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THE TELESCOPE AND MARS.

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In the early part of the year 1909, when the planet Mars was beginning to show a distinguishable disc, as seen through a three-inch telescope, I became possessed of a strong desire to view the mysteries of the red planet with better optical aid. I could detect the gleaming whiteness of the south polar cap and the faintest trace of dark shadings, but Mars was then too far away to present an impressive aspect with a telescope so small.

It was then that I decided to make a ten-inch reflector. I did not know the particulars of any part of the work except that contained in a meagre description published in St. Nicholas Magazine by Mr. John E. Mellish. It is is remarkable how much can be contained in an article so brief and as I followed the directions the cause and cure of troubles in figuring became apparent and resulted in a speculum that, unsilvered, gave surprisingly beautiful views of Jupiter and the moon Later tests have shown that the mirror was slightly over-corrected and the disc was too thin, so that considerable flexure was noticed on nights when the temperature changed rapidly. But with this home-made telescope, the noisy grinding of which had excited no mean degree of curiosity among neighbors, beautiful views of the planet Mars and Jupiter were provided. Crowds of people came to view Mars during its autumnal opposition of 1909 and not a few were able to see clearly the conspicuous features of the planet's disc. On one particularly fine evening a first view through the telescope disclosed some of the canals to an observer-guest. Many of these strange markings were seen and drawn by myself and others who had frequent access to the telescope. My dream of seeing the so-called canals, or at least the larger ones, was realized. Comparison with the three-inch refractor showed that a marvellous amount of detail could be observed with the small glass during the most favorable approach of the planet.

From 1911 to 1916 I used an eleven-inch reflector of my own construction. It embodied the best of my experience and was purposely kept slightly under-corrected to compensate for the reduction of temperature during the course of the evening's work. It had a focal length of 96 inches and was mounted out-doors without a driving clock. Magnifications up to 425 or so were practical, though some evenings a higher power could have been used to advantage had the telescope been clock-driven.

At the time of testing this mirror during construction the Foucault knife-edge test was conducted by means of an oil-flame and a pin-hole. This was the best to be obtained at the time, but since then the mirror has been examined under more favorable conditions and the detection of smaller surface irregularities made possible. By utilizing the photographic element of the light between the tips of an electric arc, focussed by an optical system behind a #10 needle-hole, it has been possible to obtain very good photographs of the true surface of the speculum. Both the camera-plate and the needle hole were at the radius of curvature on opposite sides of the central axis. The illustration shows the effect of atmospheric striae produced by heat from the hand held in front of the mirror. In a somewhat similar manner the various densities of the atmosphere due to different temperatures distort the magnified disc of a planet as seen with the telescope.

During the present (1918) apparition of Mars from the beginning of March the planet has been observed with the refractor at the Bausch and Lomb Observatory at Rochester, New York. All the observations with the reflector were made in Nashville, Tenn. As the refractor has an aperture of 11 inches (approx.) and a focal length of 162.9 inches there has been an opportunity for a comparison between the work of an excellent Zeiss objective and that of a home-made reflector. The result has been interesting and need not discourage anyone who would observe the planets with a telescope of his own construction.

Needless to say the workmanship of the refractor is of the highest order both in its optical parts and in its mounting. In the refinement of its corrections it seems to be about perfect, and the definition of both spurious disc and planetary discs is, if anything, more crisp than the image provided by the reflector. But with the best of eyepieces there is still the noticeable effect of the spectrum which is of course apparent in all refractors except the smallest. The color of Mars is apparently more yellow and less red, with less discernment of delicate surface areas where various tints of yellow-red prevail. The dark markings are more sombre or gray than delicately tinted with emerald or blue-green such as disclosed by the perfect achromatism of the reflector. The contrasts also lose appreciably on both Mars and Jupiter.

White spots stand clearly against the background of yellow or red as seen with the reflector. But though sharply defined they are less easily detected with the refractor except where of considerable size because of the lack of contrast. At least this has been my personal impression, judging from the same regions of Mars and Jupiter as seen under the best conditions. Generally the seeing is better in the more southerly latitude than in Rochester, but there have been occasions of equal good seeing.

Mars in 1918.

Mars as observed during the spring of 1918 has presented favorable views of the extreme northern latitudes. In 1909 the same opportunity, due to the inclination of the planet toward the earth, was presented for extreme southern polar regions. Unfortunately earlier observations this year could not be conducted from the observatory during the winter because of the accumulation of snow and ice around the dome-shutter. With the simple erection of a small balcony extending a few feet outside the dome at the shutter it would be possible for the observer to clear away the ice each day and thus make use of what evenings of good seeing may prevail in the cold months. This defect will undoubtedly be corrected when the observatory actually becomes a working institution, its present use being merely permitted the writer through the courtesy of the Bausch and Lomb Optical Company.

On March 20, 1918, longitude 0 degrees on the central meridian, the northern polar cap seems to have about reached its minimum size. It seems to have been then about 324 miles in diameter. The cap in longitude 232, on April 2, appeared as a minute brilliant point surrounded by a faint border and beyond the border extended a diffused halo which was almost as bright as the cap and of apparently the same color, about 10.2 on the standard scale suggested by Professor William H. Pickering (Pop. Astron. No. 7, Vol. XXV). This is only estimated and is therefore as approximate as could be determined by the observer's judgment without measurement.

An interesting phenomenon was observed on May 4, 5, and 8. In longitude 295.8, on May 4, the cap had a decided extension as shown in the illustration. On the next evening this had appreciably diminished as seen on the drawing. The contrasts on both evenings were heightened by the film of a damp haze which presented a disc more red than usual, and which was more in evidence on the evening of the fourth, producing better seeing and better contrasts on that evening. The phenomenon of a bright halo around the cap was again observed on May 8, at 14h 5m, G. M. T., Long. 268. As the summer solstice occurred on about March 24, the heliocentric longitude for Mars being

88°.35 on March 20, the phenomenon is interpreted as one of local clouds and snow, perhaps suggesting the relapse of the Martian arctic into temporary conditions of winter. The appearance of a sombre border around the extension, as observed on May 5 when it had decreased in size, suggests the melting of snow.

One interesting feature of the present opposition and also that of 1916 has been the fullness of development exhibited by the curved shading known as the Thoth-Nepenthes. By way of comparison I have copied from my record-book drawings of this region as shown in 1911 and 1914. From the data it appears that alternation of development actually occurs on such a scale that moderate telescopes can disclose it in several of the more conspicuous instances, of which this is one (See Dr. Lowell's "Mars and its Canals," page 323).

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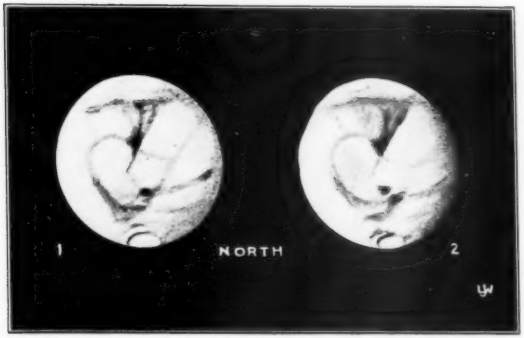
STAR CLUSTERS.

RUSSELL SULLIVAN.

The earliest scientific observation of a star cluster was made by Aristotle on a fixed star with a faint tail which he saw near the bright star Sirius. He said that it was too faint for direct observation, but could be seen by turning the eye slightly to one side.[1] This object was doubtless the cluster M41, situated 4° south of Sirius, close to the star 12 Canis Majoris, and just visible to the naked eye; it most likely has the distinction of being the faintest object ever observed in classical antiquity. In later times Hipparchus and Ptolemy were familiar with the larger clusters, Praesepe in Cancer and the double cluster in Perseus. Both are among the five cloud-like objects noted in the Almagest[2]—the other three being mere chance groupings of a few faint stars. In the 15th century Ulug-Beg included the same clusters in his catalogue. There were no observations of *globular* clusters in ancient times. In 1716 Halley made a list of six "lucid spots", including the great globular cluster in Hercules, the globular cluster M 22 in Sagittarius, the globular cluster ω Centauri, and the open cluster M 11 in Aquila. The other two objects were the Orion and Andromeda nebulæ. These lists were followed by the work of the Rev. W. Derham, Lacaille and Messier, but there was little known until Sir William Herschel commenced his observations in 1786. He was

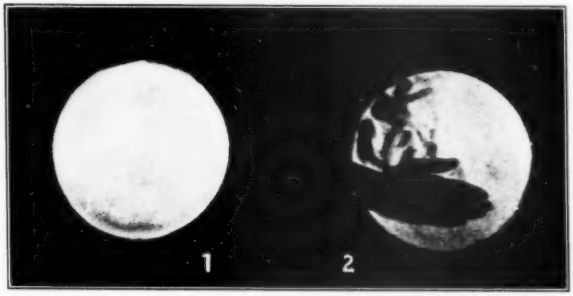
PLATE XVI



Mars in 1918

No. 1. May 4. Showing the curved Thoth-Nepenthes in longitude 295°.

No. 2. May 5. Showing the same region. Note the white extension of the Northern polar cap. The Martian date for May 4 is ☉ = 108.6, or July 11.



Photograph of the Figure of the 11-inch Reflector

No. 1. The parabolic figure of the 11-inch mirror as seen when the cone of rays is intercepted near the radius of curvature. The illumination is from the bottom toward the top.

No. 2. Illustration of the effect of bad seeing produced by heat emanating from a hand at normal temperature. The figure of the mirror is distorted by the various densities of the air caused by the heat-waves.

Both exposures are of 1-5 of a second duration. The photo-chemical light of the electric arc is the light-source.

Drawings by Latimer J. Wilson,
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the first to postulate the existence of a "clustering power" by which the stars were drawn together and held in densely packed aggregations; Sir John Herschel continued his father's work in the southern hemisphere and noted that the stars in globular clusters are divided into brighter and fainter magnitudes—according to Plummer, the first recognition of the existence of giant and dwarf stars.[3] From that time until a few years ago astronomy confined itself to describing and defining the positions of star clusters, but in the last few years Shapley, Slipher and others have extended our knowledge of clusters and the universe far beyond the greatest hopes of the old astronomy. Large instruments show the average cluster as a mass of glittering bluish points of light with an occasional red or yellow star to emphasize the contrast with its neighbors. Tennyson, when looking through a large telescope at the double cluster in Perseus, exclaimed: "One doesn't think much of the county families after that."

Turner has demonstrated the existence of a solar cluster by comparing the numbers of bright and faint stars—there are too many bright stars in comparison with the faint ones—and he concludes that the bright stars are on the whole nearer than the faint ones and consequently companions of the sun drifting with it in its voyage through space.[4] Other evidence suggests the same conclusion. The giant stars of early and late type are very remote, while stars of Class G and related classes (the solar type) appear to be comparatively near neighbors of the sun.[5] Thus we may be said to live in G space or regions containing stars of advanced spectral type.

Moving clusters are loose aggregations of stars moving towards a common point with the same speed and often the same spectral type. No doubt all clusters are moving, but the name refers to loose, apparently unconnected, groups of stars often found in widely separated parts of the sky. Professor Lewis Boss found such a cluster in the Hyades—30 or 40 stars of similar spectral type, all at the same distance, moving with the same speed and appearing to converge towards a common point. They are, most likely, a globular cluster at a great distance, but at our distance appear to be a loose group of stars. This conclusion is denied by Shapley, who says that there are not enough stars for a true globular cluster which should embrace thousands of stars.[6] The Pleiades furnish another example of a moving cluster, and there are clusters of helium or "Orion" stars in Perseus, including the star α Persei and part of the famous double cluster. There are also clusters of moving stars in Scorpius and Centaurus and a swiftly moving cluster in Cygnus, which includes the star 61 Cygni, one of our stellar neighbors. Quite recently Innes and Voûte in the southern hemisphere have found a faint red star $2\frac{1}{2}^\circ$ from α Centauri, the famous

binary, but moving with it at the same speed and in the same direction; thus α Centauri with its close companion and the distant red star present a beautiful example of a moving cluster on a small scale. Doubtless the most interesting group of wandering stars is the Ursa Major cluster[7] (investigated by Hertzsprung), including five of the stars in the Big Dipper (except the end star in the handle and the star at the top of the bowl nearest the pole star). Sirius is also a member, as well as β Eridani, β Aurigae and α Coronae Borealis. This cluster is flat like a fleet of ships sailing on the ocean, and, strange to say, the sun lies in the plane of the cluster. Although the sun is not a member, yet it is passing through it in a different direction. The cluster might be compared to a flock of birds flying over-head,—several birds in the north representing the stars of the Big Dipper, and one in the south representing Sirius. This cluster is about 150 light-years in length and the sun is only 8 light-years from Sirius, so, comparatively speaking, we are quite close to Sirius. These stars all belong to the early spectral types and most of them form binary systems. Such distances are so vast that no sensible gravitational attraction is exerted on the sun, and the same is true of interloping stars in other clusters which will doubtless pass out in the course of time without having their orbits disturbed by the combined but feeble attraction of the cluster.[8]

Melotte in his recent catalogue has divided the star clusters into four classes.[9] In the first division there are 82 globular clusters with central condensation; second division, loose clusters with well defined outline; third division, loose clusters with irregular outline; fourth division, coarse, large clusters like the Pleiades, Hyades and Coma Berenicis—there are 14 of the latter—making a total of 245 clusters in the catalogue, the majority of which are within 30° of the plane of the Milky Way. This galactic concentration shows that they are quite remote, but at the same time implies that they are members of our own universe. In Class I the majority of the globular clusters are under five minutes of arc in diameter—there are 22 between five and ten minutes in diameter and 11 between ten and twenty minutes in diameter. The loose clusters comprising Classes II and III, which form practically one class, with two exceptions, lie within 30° of the galactic plane, while the majority are within 20° of it. Between Centaurus and Cygnus they form a narrow belt, but they spread out from Cepheus down to Argo in the southern hemisphere. All the clusters in Class IV are within 30° of the galactic plane. Melotte has remarked that it is a curious fact that the large clusters like the Pleiades (found recently to have a diameter of 6°),[10] Hyades and the Perseus cluster have about the same galactic longitude, i. e. 140°.

The globular clusters are different objects from the open clusters and irregular star-clouds of the Milky Way. Hinks was one of the first to show that the globular clusters are confined almost exclusively to one hemisphere of the sky, the pole of which is in the galactic plane at 300° galactic longitude, near the star η Arae in the region of Scorpius and Sagittarius.[11] This part of the sky also contains one of the ellipsoidal vertices, or points towards which the stars as a whole tend to drift by virtue of the phenomenon of star-streaming. It might also be inferred that the globular clusters have a similar tendency to drift towards this point in the sky,[12] along with the stars and the planetary nebulae (the latter have recently been shown by Campbell and Perrine[13] to partake of preferential motion). If such is the case the globular clusters would belong to our stellar system. However, there is no such crowding towards the ellipsoidal vertex in Orion, which should also share in the general concentration. Melotte has also found that there is a marked concentration of globular clusters at galactic longitude 325° in the constellation Scorpius. Half of the globular clusters in the sky are crowded together in this brilliant region of the Milky Way[14]. Thus the globular clusters are approximately in one hemisphere of the sky, and generally speaking are only to be seen among the summer stars. This concentration has never been satisfactorily explained, but it implies a relation with the Milky Way. The globular clusters can not lie directly beyond the Milky Way, because their light would be obstructed by the vast masses of dark, opaque nebulosity which Barnard and others have shown to exist in low galactic latitudes. If they are farther from us than the Galaxy, they must lie to one side or the other in order to avoid these obstructing dark materials.

Slipher has investigated the radial velocities of a number of globular clusters and finds that they are much smaller than the average radial velocity of the spiral nebulæ.[15] The globular clusters are moving through space with average speeds of 90 miles per second. The fastest stars (type M) have average speeds of ten miles per second (and more, depending upon faintness and size), while the spiral nebulae are moving at the tremendous average speed of 240 miles per second. Thus the globular clusters appear to fill the great gap in speed between the stars and the spiral nebulae. The Hercules cluster and one or two others are moving faster than the average globular cluster. The great difference in speed between the two classes of objects implies that the globular clusters are not independent universes, as the spirals are thought to be.

Shapley has determined the color indices of a great many stars in the Hercules cluster by a photographic method.[16] He finds that 75% of the 400 brightest stars are redder than the solar type, and that of

the 400 faintest stars 85% are bluer than the solar type—there are about 50,000 stars in the cluster. The brightest stars are red, the next brighter white, and the fainter ones yellow, while the very faint ones are also red. In comparing the bright red cluster stars with such a well known red star as Antares, which is about 3,000 times brighter than the sun, he deduces the fact that the red stars in the Hercules cluster are giant stars and have a very great luminosity in order to be seen at such vast distances. The white stars are smaller and are comparable to Sirius and Vega, which are about 100 times brighter than the sun. The yellow stars in the cluster may be compared to stars approximately as bright as the sun. Thus, the cluster must be at a vast distance in order to diminish the brilliance of such enormous stars. This discussion involves H. N. Russell's theory of giant and dwarf stars—the existence of these two classes of stars has recently been *proved* by the spectrographic determination of absolute magnitudes by Adams and Joy at Mt. Wilson.[17] Shapley has carried this remarkable investigation farther and has shown that the globular clusters are really not globular, but elliptical with equatorial planes and poles. The ellipticity is not apparent among the bright stars, but is made evident by counts of the faint stars in the clusters. Photographs of ω Centauri show it even with the brighter stars. The ellipticity in some cases amounts to 30°. M 10, however, presents no ellipticity, thus giving the appearance of a true globular cluster. In this case the pole of the cluster is most likely pointed towards us, with the equatorial plane inclined 90° to the line of sight.[18] The flattening of these clusters implies a degree of rotation, comparable perhaps to the rotation found in certain planetary and spiral nebulae. Poincaré has assumed that the Milky Way is rotating on account of its flattening which would give it the appearance of a flattened spiral nebula if seen from a great distance in space. Slipher has shown that the spiral nebulae tend to move edgewise through space in the plane of their flattening, and it is reasonable to suppose that the globular clusters also tend to move edgewise in the plane of their ellipticity. The axes of the clusters lie at various angles to the plane of the Milky Way.

A number of years ago Bailey and others proved the existence of many variable stars in some of the globular clusters.[19] These stars go through their variations with great regularity in periods of ten to fifteen hours. There is a sharp rise to maximum and a slow fall to minimum. It is not known whether variation is caused by the eclipse of a companion star or pulsations (tidal or otherwise) in the body of the star itself. Recent evidence favors the latter view.[20] Miss Clerke has well remarked that in the case of eclipsing variables, the eclipse is the incident in the general steadiness of light; in cluster variables the

increase of light is the incident in the general faintness of the star. Professor E. C. Pickering said of the cluster M3: "Out of a thousand stars one-seventh are variable, all have a period of about half a day, and their periods are known within a fraction of a second. Their light changes so rapidly that in one case it doubles in seven minutes. It is a strange thought that out of a thousand stars, looking exactly alike, there should be a hundred little chronometers keeping perfect time, and whose rate is known with such accuracy."[21] The cluster type of variable is found among variable stars of the δ Cephei type in the sky at large. In fact, cluster variables and Cepheids of short period probably belong to the same type. Cepheid variables are mostly found in and near the Milky Way, and Shapley has found them in considerable numbers in some of the globular clusters. More remarkable still, they lie in the axis of symmetry (or galactic plane) of the clusters themselves, thus marking out the Milky Way of each cluster. Early type stars of Class B are also found in the galactic plane of the globular clusters; they are always near the plane of our own Milky Way and thus the similarity of structure becomes more and more apparent. The distances of Cepheid variables are now known from a relation between their periods of variation and their absolute magnitude (or actual brilliance) which, when compared with the apparent magnitude, gives the distance. The periods of the cluster Cepheids have thus indicated the distances of the clusters—no cluster is nearer than 30,000 light-years—distances comparable to those of the spiral nebulae. A relation between the Cepheids and certain bright stars in the same cluster gives a clue to the distance of similar bright stars in clusters without variables.[22] The vast distances of the clusters can also be inferred by comparing their high radial velocities with apparent absence of proper motion. Large proper motions doubtless exist, but they shrink to insignificance at such stupendous distances.

These researches show that the universe is larger than former observations have indicated. The statistical evidence tends to show that the globular clusters belong to our own universe, but the internal evidence of the clusters themselves indicates that they are vast, distant systems of stars unrelated to our Milky Way. The solution of this problem rests with the astronomers of the future. We must either regard the globular clusters as remote, independent universes, or accept them as miniature Milky Ways in our own stellar system.

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NEBULAR EVOLUTION.

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PRELIMINARY.

It is to be regretted that there is not the same opportunity for criticism in the astronomical field as in the literary field, though the necessity is greater. In matters of æsthetics there is always a large audience awaiting a critical work which possesses an appreciation and understanding little below that of the author. There is no laity and there are no Popes. But in matters astronomical there is a laity to which a small hierarchy indulgently imparts certain facts, and the laity is not expected to inquire too curiously into these facts. Above the hierarchy, which is composed of teachers of the subject, are certain scientific Popes and neither laity nor hierarchy must question their edicts. The greatest Pope of all times was Aristotle.

Such a system of knowledge "by authority" is convenient and time-saving, but it leads to difficulties because a man can not really "know" what he does not "understand." Eve wrote in her diary that Adam

"knew a great many things, but they were not so." I have before me two text-books of astronomy in which it is stated that the varying eccentricity of the earth's orbit causes changes in the moon's mean motion, and then an erroneous explanation is given. The great Pope Laplace truly proved that one change must be followed by the other, but the hierarchs in question have mis-apprehended and mis-stated his explanation.

Authority is especially dangerous when applied to theories, using the word in the sense of a supposition, conjecture or surmise. Newton truly said: "Hypotheses non fingo," for his so-called theory of universal gravitation is not a theory but a law. Observation and analysis turned the conjecture immediately into a certainty. The proof of the law rests upon the theory of probabilities.

In the same way Laplace propounded his nebular hypothesis simply as a problem in probabilities. A certain number of bodies—members of our solar system—all possessing similar properties, he showed that the probability that they were once materially connected or all once formed parts of a single body, was astonishingly high. Kant had previously, but without Laplace's knowledge, been led to a similar conclusion by an analogous process of reasoning. But this was not a theory or hypothesis; it was a fact which he demonstrated with overwhelming probability. After establishing this fact he threw out certain conjectures as to what might be the development of the primitive mass which once existed. He applied his reasoning only to our solar system. He had never seen a nebula and nobody at that time, not even Sir William Herschel, knew that spiral forms existed. It is to be regretted that he did not know of these spiral forms, as in that case he certainly would have examined the problem dynamically, instead of merely as one in probabilities. The matter did not engage him deeply and he left it merely as a note in his Système du Monde. He seems over insistent in warning that his suggestion as to the splitting off of rings was merely a surmise and not to be accepted as a fact. As another writer has said, this hint was "for the consideration of his successors with the hope that they might be able to discover the full truth, which he confessed was hidden from him."

Contrast with the above the methods of present-day manufacturers of theories. Their idea seems to be that everything must be explained. If anything is not understood they will promptly furnish a theory or hppothesis to fit the case, and loudly announce: "Here are the facts at last." Subsequently they advertise the theory as one would a patent medicine and with equal success.

I have a letter from the propounder of a well-known theory from which it is evident that his ideas of dynamics and analysis are

extremely hazy. This hypothesis purports to explain how universes are formed, but if the simplest of dynamical problems were given the author, it is evident he would be unable to solve them. And yet his theory is a dynamical one!

But non-mathematicians are not the only offenders. The late Professor G. H. Darwin, it will be remembered, startled an unsuspecting world one day by announcing that the moon had originally been torn out of the earth, and that this was the only case of the kind that had ever happened in our system. If anybody doubts it, there is the hole the moon came from. Go and look at it. But the trouble is nobody seemed to doubt it. Being a kind of little Pope all the hierarchs accepted the edict without question, for none of them ever went over his work, or could have understood it, if they had. Hence the need, which I have emphasized, for constant and competent revision in order that science may be made safe for democracy. Sir Oliver Lodge once said in a lecture: "It is the fashion now-adays to speak of Darwin as the Newton of the nineteenth century. I never hear this without a shudder." And the writer never hears the son spoken of as an "authority" without a shudder.

Nebular Evolution.

We know that there is a small amount of comminuted matter within the gravitational limits of our solar system, as evidenced by meteors, comets, the zodiacal light and some other phenomena. The particles of this matter may vary in size from an atom to a mass of several tons. They probably represent the waste and remnants of the original nebula from which the system was formed, for we have no evidence that any of it certainly came from without. On the contrary it is probable that the meteor trains which compose the most eccentric comets have always been and always will be parts of our system. The total of this stray material is an insignificant fraction of the mass of the system. That there is any considerable amount of matter in the vast interstellar spaces seems improbable. The fact that there is no appreciable absorption of light generally or in particular directions speaks against it. Wherever we find matter we know that it existed originally as a nebula, and where we find a nebula, which we know to be a mass of gas, we know that eventually it will become matter such as our system. There seems to be little doubt that all gross matter existed originally in a gaseous form.

In the illimitable ocean of ether, which is a kind of matter, we find at certain points stains and patches of light which the spectroscope assures us are glowing masses of gas. We say glowing and not incan-

descent, because they may not be very hot. The shapes of these patches are most irregular. They have no shape, but lacking all scheme of relationship or distribution can best be described as chaos. They resemble the fractures visible in a clear glass after it has been subjected to twisting and shearing strains. As we can trace forward the transformation of such a chaotic mass into a regular celestial system, so we should be able to retrace its past. Its atoms could not have existed in their present situation forever, or they would long since have formed the system they are now proceeding to form. And they could not have existed in other far distant regions and then all have been fortuitously brought together, for the chances are too heavy against that. There was nothing to bring them together, for although theoretically we can impose no limits to gravitation, practically two particles separated by a sufficient distance are immune to each other, unless we are dealing with infinities of time, and we know that celestial processes consume but small fractions of infinity. We are driven then to the conclusion that there was a time when the nebula was not in existence and that it had its birth in situ. Further it must have sprung from the ether, which existed there as it exists everywhere, and it must have been by some sort of condensation of the ether as there is no doubt that the nebula is denser than the ether. Otherwise it could not possess its gravitational properties. We may make all kinds of surmises —we may suppose that the ether suffered a local strain or compression, but eventually we shall come up against a wall beyond which we cannot advance. For no one will ever be able to explain the universe completely. A finite mind cannot grasp the infinite.

We can find in the heavens all kinds of nebulas—some which have just been formed, some in all degrees of advancement, and the finished product. As soon as particles denser than the ether exist, they must exert upon each other mutual attractions. The process of condensation must continue and substances such as the hypothetical nebulium and hydrogen and helium begin to be formed. Possibly two atoms of hydrogen pressed together form at atom of helium. Possibly nebulium is some lighter substance or substances from which hydrogen is formed, but of such matters we know little or nothing.

Starting with chaos, as seen in many patches in the sky (the great nebula in Orion), we shall attempt to forecast its development or evolution. Generally the mass will not be homogeneous, so that there will not be a parallel development throughout. Local development will be uninfluenced by remote portions. By the kinetic theory of gases, the original motions of the atoms will be accelerated, condensations about certain centres will result and heat will be developed. From this point we shall abandon all surmise and proceed upon a strictly mathematical basis.

We shall suppose a mass not too diffused and homogeneous enough to be a distinct gravitational entity, so that from first to last it shall constitute the same system. The tendency of such a mass at first will be to assume a spherical shape. There will be condensation towards the center. The superficial parts will cool more rapidly than the inner portions and there will be local condensations which may be at first like water particles in a cloud, or solid particles varying in size from mere specks to meteorites of considerable size. Happily the mathematical treatment of a swarm of particles, whether of the size of atoms or of meteorites, under their mutual attractions and collisions, is practically the same. That is, the kinetic theory of gases does not have to be modified if we suppose the atoms to have considerable masses.

If we suppose that the system as a whole has no preponderating rotational moment about any axis, the future of such a system is a star cluster, globular in form. Under their mutual attractions and collisions the particles will increase in size, but with this increase in size the collisions will decrease. The separate masses will revolve in all planes about the center of inertia of the group, and as the attraction towards this center is nearly proportional to the distance, they will perform elliptic harmonic orbits about the center, the center of inertia being the center of each ellipse. If a body heads directly for the center and has a clear path, it will oscillate harmonically back and forth through the center. The suns constituting an ordinary star cluster are separated by considerable distances, perhaps many times the distance between our sun and Neptune, so that collisions may be infrequent. There would be a tendency for the masses to heap up in the center from the first. There must be collisions, but the effect of a collision is not what is generally supposed. The general idea is that if two large bodies met head on with sufficient velocity, the result would be a vast cloud of gas or vapor. The familiar method of showing this is to calculate the amount of kinetic energy, take the equivalent amount of heat and prove that this heat could vaporize the entire mass and then some. But practically there is never such a result. While of course much heat is evolved and there is some liquefaction and vaporization of matter, the greater part of the energy remains kinetic. Collisions have been frequently observed. There is little doubt that the Novae are such cases, but the noticeable part of such phenomena is that the subsidence of the catastrophe is almost as rapid as its development. Nebulae do not originate in this way.

We have supposed our nebula to be a dynamically isolated system. It is subject only to its own mutual or internal forces. But we cannot suppose every atom to have been formed originally with absolutely no motion. The ether from which it was formed might have been in

motion. The chances are that it was. If we represent the original amount and direction of the motion of the center of inertia of the system by the vector ρ, then ρ will remain constant, for there is nothing in the system which could change its value. We shall now state a general dynamical principle. Let us draw through the center of inertia some vector and drop on this vector a perpendicular p from every atom. Designate the original velocity of each atom perpendicular to the plane through the vector and the atom by v, and the mass of each atom by m. Then Σmvp* will be a function of the direction of our vector. That is this integral will have a single definite value for any particular direction of our vector, or axis. But there is one axis, and only one axis, for which the value of our integral is greater than for any other axis. The integral expresses the moment of momentum of the system about an axis, and there is one axis, fixed in direction, about which the moment of momentum of the system is a maximum. This vector, or axis, is called the Invariable Line of the system, and the plane through the center of inertia perpendicular to this line is called the Invariable Plane of the system. The moment of momentum of the system can be represented by a vector having the direction of the invariable line and a length equal to the amount of the moment of momentum, and this vector remains constant forever. Representing this vector by μ, and the velocity of the center of inertia by ρ, these two vectors remain constant forever and determine the system. In the preceding case we supposed that there was no axis about which the system had a preponderating rotation. Now with a great number of particles the chances are that there will be as many moments about one axis as about any other, just as in a busy street the chances are that there will be as many persons going in one direction as in the opposite. And in such a case the result will be a globular star cluster. But everything that can happen, will happen, so that there must be some nebulas which from the beginning had a preponderating rotation about some vector μ, and this vector μ must remain constant forever. In this second case the evolution will be entirely different. It will be understood that when we say there is no moment of momentum about any axis, we do not mean that there absolutely is no rotation, for the chances of that are very slight, but we mean that the rotation is slight or inappreciable. Perhaps the chances are about even that a nebula should have no appreciable rotation or a marked rotation. In that case there would be as many globular star clusters as rotating nebulas. We thus see that the evolution of a nebula depends entirely upon the initial conditions.

* If the original atoms were manufactured uniformly, or the original substance was, say nebulium; we could write $m\Sigma pv$.

Owing to centrifugal forces a rotating nebula will tend to flatten out into its invariable plane. We have seen that we can treat the mass as a fluid body even though it be a swarm of meteorites and not a gas. But originally the nebula is a gas. Now all gases possess a property known as viscosity. That is, owing to the mutual friction between the particles, such a mass as our nebula will tend more and more to perform its rotation about the invariable line like a rigid body, or its particles will tend to assume a common angular velocity. The pressures perpendicular to the invariable plane, which are due to the mutual attractions of the particles in this direction, must be greater than the radial pressures since these are lessened by the centrifugal force. Our body has now become a flattened or lenticular disc rotating about the invariable line. It is conceivable, if there is a nearly perfect symmetry in the distribution of the particles, that a very rapid rotation may throw them out into a ring, in the center of which there may be a central sun. Or possibly the whole lumen of the ring may be filled with matter. While such a result may occur, the chances are much against it.

We have a fluid rotating lens-formed body. There is a residual pressure perpendicular to the disc, tending to squeeze the matter out from the edges. Owing to viscosity the mass tends to assume a uniform angular velocity. The centrifugal force, or force tending to flatten out the mass, is proportional to the distance from the axis for all points. But as the mass flattens from a sphere to a thick lens-shaped body, what are the chances that the edge will remain perfectly circular throughout? Very small, especially if the rotation is slow. Generally one diameter will be shorter, even though slightly, than any other. Instead of being perfectly circular, the lens will be slightly oval. At the extremities of the greatest diameter the centrifugal force will be greater than at the extremities of the shortest. The lens will tend to spread out in this direction and to collapse in a perpendicular direction. The considerable pressure at the center accelerates the flow outward along the greatest diameter. Even if we suppose the flow from the center to begin only along one radius, by reason of the fact that reaction is always equal to action, a corresponding flow in the opposite direction must follow, so that the further flattening of the mass must, in general, be a flow outward into two oppositely directed arms, with a corresponding collapse in a transverse direction. The oppositely outflowing arms will in general be symmetrical, though not exactly so. Naturally they could not each receive exactly the same amount of matter, but generally there will be no marked difference. Owing to the fact that the moment of momentum of each particle must remain constant, its angular velocity about the axis must decrease, as it moves

outward, inversely as the square of the radius. We can consider each particle as projected outward from the rim of the lens, and we now trace its trajectory. In Figure 1, let r_0 be the radius of the lens, r'_0 the

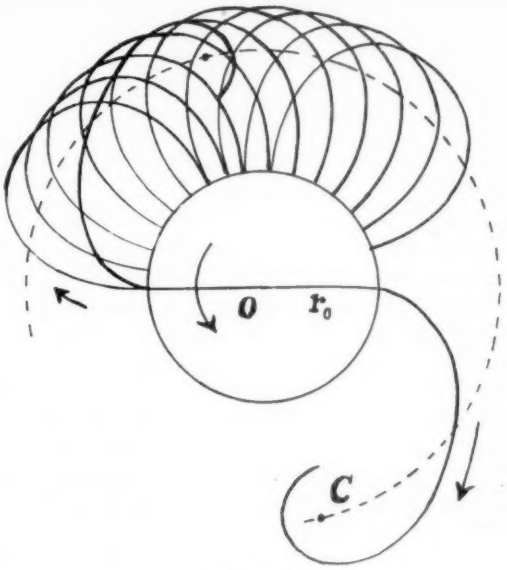


FIGURE 1.

velocity with which a particle is projected from the edge $1/\kappa$ the constant moment of momentum, and k the gravitational acceleration at unit distance. The lens is rotating positively, as shown by the arrow. The radial acceleration is

$$r'' = \frac{\kappa}{r^3} - \frac{k}{r^2},$$

where r is the distance from the centre. The particle proceeds outward to an extreme distance determined by the equation

$$\frac{1}{r} = \frac{k}{\kappa} - \sqrt{\left(\frac{1}{r_0} - \frac{k}{\kappa}\right)^2 + \frac{r'^2_0}{\kappa}}.$$

The complete trajectory is shown by one of the curves attached to the rim. These curves represent the trajectories of successive particles as they leave the rim at equal intervals of time. If at any instant we connect the positions of these successive particles, we shall have the form of the outward streaming arms at that instant. This form is

indicated by the outward curving spirals. But on reaching the outermost distance, the particles have no radial velocities and, as they begin to drop back, come under the gravitational influence of the following part of the stream and are thus deflected from their uninfluenced paths. The stream thus curls round some point C, and joining with the portion behind becomes a detached body. It is evident that this detached body will have a negative rotation. The dotted circle, at a distance determined by the equation

$$r = \frac{\kappa}{k} ,$$

is the distance at which the gravitational and centrifugal forces are equal. If, therefore, the center of inertia of the detached mass coincides with a point C on this circle, the body will revolve in this circle about the parent mass. But if the center of inertia is not on this circle, the orbit will be an ellipse. If the outstreaming arms are broad these curls or eddies may form at several points, constituting detached bodies which all have a negative rotation. The detached body has a negative moment of momentum which does not remain constant, because the tidal couple set up by the parent mass eventually brings the rotational and revolutional periods into coincidence. Nevertheless the total moment of momentum of the system remains constant forever. Whether we call the detached mass a sun or a planet or a satellite is immaterial. As its mass contracts its rotation will at first increase, but finally decreases to the revolutional period. Our new body is now in a condition to repeat on a smaller scale the whole process over again. Theoretically the process might go on indefinitely into many generations. The new body is supreme in its own sphere though ruled by the parent body.

The extrusion of matter into the arms may cease and the central nucleus may then simply contract into a central sun, or the evolution may take another course which we shall examine directly. But, instead of ceasing, the extrusion may continue until the nebula is reduced to a long fusiform body twisted into a spiral. It all depends upon the initial conditions. We have an example of this in the nebula N. G. C. 7479, in Pegasus. A photograph of this object may be found in Sir Robert Ball's "The Earth's Beginning," p. 345. It looks like a gigantic reversed S in the sky. The arms may possibly curve round into each other forming two rings which may later become twin suns revolving about their common center of inertia. We are not saying that all twin suns are thus formed, but this is a possible way and since everything that can happen does happen, some twin suns must have been formed this in way. Or this nebula might develop into a triple or quadruple or

multiple system of suns. The nebula N. G. C. 628 in Pisces has taken a different turn in its development. Most of the matter has been thrust out into long thin arms and a large number of suns, at equally spaced distances, are strung on these arms like beads on a thread. We often see these rosaries, but the motions of these suns having carried them away from their spiral configuration, we forget that they must have originated in a spiral.

(To be Continued.)

THE TOTAL SOLAR ECLIPSE OF JUNE 8, 1918.

H. C. WILSON.

Observations of the eclipse appear to have been very successful on the whole, in spite of the clouds which overspread much of the path of totality. The only stations reported where the sun was entirely obscured during the total phase of the eclipse were those at Denver, Colorado, and in Florida. At several places fortunate breaks in the clouds occurred just at the critical time and at others very thin clouds obscured the fainter features of the corona but permitted the brighter parts to be observed.

At Denver, unfortunately, where much was expected from the observations with the 20-inch telescope, dense clouds covered the sky all the afternoon and no glimpse was had of the eclipse. A spectrograph, especially adapted to determine the rotation of the corona had been attached to the great telescope, and the Allegheny Observatory star camera was mounted on its tube for the purpose of photographing the stars in the vicinity of the sun and testing the Einstein theory of Relativity by accurate measurements of the star places before, during, and after the eclipse. The Chamberlin Observatory, at Denver, was the only permanent observatory along the line of totality and it seems a pity that it should be the one to suffer most from clouds.

At Green River, Wyoming, where the Yerkes and Mount Wilson parties were located with their fine outfit and numerous observers, clouds interfered with, but did not wholly obscure, the phenomena of totality. An independent party here seeing that a cloud was likely to cover the sun at totality leaped into a powerful automobile and raced 3½ miles to the northwest thus securing a view and photographs of the eclipse in clear sky. An account of this will be given in the October issue of POPULAR ASTRONOMY.

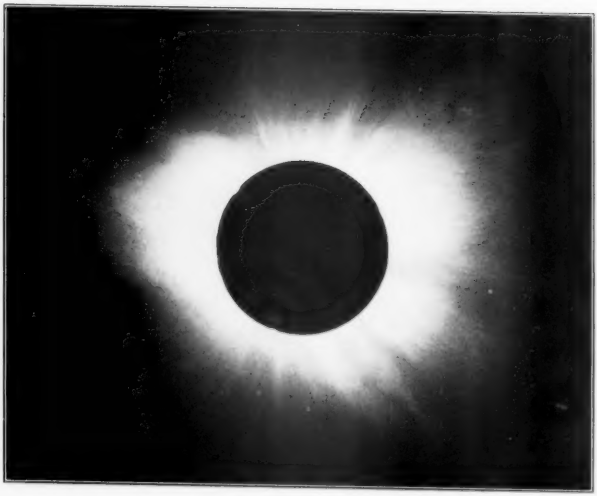
At Goldendale, Washington, Baker, Oregon, Rock Springs, Wyoming, Matheson, Colorado, and near Hartland, Kansas, the weather was clear, at least during totality, and successful observations have been reported.

The writer was located at Fraser, Colorado, just over the high range of mountains west of Denver, in company with Professor F. P. Leavenworth and Mr. W. O. Beal of the University of Minnesota Observatory, and Mr. John H. Darling of Duluth, Minn. We found a good observing site on the grounds of the Arapahoe Lodge, on the ranch owned by Mr. and Mrs. Wessel, who were very kind in ministering to our wants and in assisting us at the time of the eclipse. The altitude of our station was nearly 9000 feet, and much snow could be seen on the mountain peaks in all directions around us but there was no snow at our level.

ECLIPSE STATION OF THE MINNESOTA PARTY AT FRASER, COLORADO.
LOCATION INDICATED BY THE ARROW.

During the four days we were at Fraser the nights were beautifully clear. The mornings were clear with the exception of thin streaks of very high haze, but in the afternoons local clouds developed and small thunderstorms occurred with occasionally a little rain. On only one day was the western sky clear at the time predicted for totality of the eclipse, so that we were very dubious as to our prospects of observing the eclipse. Saturday, June 8, was the most promising in the morning, the sky being perfectly clear, but in the afternoon the usual clouds formed. They were broken summer clouds and a gap occurred just in

PLATE XVII



PHOTOGRAPH OF THE CORONA JUNE 8, 1918, BY D. W. MOREHOUSE AT MATHESON, COLORADO.

Exposure 3 seconds between the 8th and 11th seconds of totality.

time for an observation of the first contact, which came at $10^h\ 10^m\ 36^s$ Greenwich mean time,—about 8 seconds early according to the time read off from the American Ephemeris Supplement map, but 4 seconds late when corrected according to the table on page 296 of the May number of POPULAR ASTRONOMY.

Fifteen minutes before totality a large clear space opened around and west of the sun, but a black cloud to the northwest was moving straight toward the sun and our hopes were very weak that it would delay long enough for us to observe the total phase of the eclipse. However, we prepared to go through the program which we had rehearsed many times during that day and the preceding. Nearer and nearer approached the cloud and nearer came the time predicted for second contact. The bright crescent became exceedingly narrow and everything about us took on a weird look. Toward the northwest we had a clear view over a valley for thirty or forty miles, but we could not see the moon's shadow coming. That was masked somehow by the clouds. Mrs. Wessel watched for the shadow-bands but these were not seen. Suddenly a greater darkness came upon us and I thought the cloud had reached the sun. But, no! "Time"! called Mr. Darling, who was to note the moments of second and third contacts with the four-inch telescope. Mrs. Leavenworth began counting the seconds and our program for the minute and a half of totality began to be carried out. Professor Leavenworth and Mr. Beal made two exposures each with the 5-inch and 2-inch star cameras. The writer made four exposures with a two-prism slitless spectrograph. During the two long exposures of 30 seconds each, I looked up to see the corona, fearing that it would be lost in the cloud. But there it was, very brilliant, very different both in shape and color from those which I had seen in 1889 and 1900. I was surprised by the bluish white color of the corona. In 1889 and 1900 it had much more of the yellow and red in its color. This was probably due to the high altitude of Fraser, the former eclipses having been viewed from altitudes near sea level. Instead of the greater streamers of the corona being arranged east and west parallel to the ecliptic, they seemed to come from all parts of the sun's disc. The narrow polar streamers, so conspicuous in 1889 and 1900, were not noticeable. Three brilliant red prominences, about 120° apart around the limb of the moon, could be seen with the naked eye and were very conspicuous with the aid of field-glasses. "Time"! Called Mr. Darling again, and totality was over. Quickly the atmosphere became brighter, but within a minute the dense cloud covered the sun again and but little could be seen of the eclipse until near the end, when the sky cleared so that last contact could be observed. This was observed by the writer, the time being noted by the other three men of the party.

The three watches, when corrected by the telegraphic time signals of the four days, agreed within 1 second, giving as the time of fourth contact $12^h\ 26^m\ 40^s$ Greenwich mean time. This was 16 seconds early by the map time and 4 seconds early according to the corrected prediction. Unfortunately we had not arranged for anyone to note the times of second and third contacts, as all were intent on other special problems.

My exposures with the spectrograph during totality came out fairly good. The plates used were Seed's Nonhalation Ortho and yielded spectra extending from $H\alpha$ to H and K and beyond. The exposure of about one-half second duration just after second contact shows about 150 lines, probably all chromospheric. The 30 second exposures during totality were much overexposed in the yellow and blue parts of the spectrum. The coronal ring, falling between the maxima of the spectrum shows very plainly on both exposures. The broadening of the lines due to the drift of the sun in 30 seconds will, however, prevent accurate measurements of position. The exposure just after third contact with an exposure of approximately a second is a little overexposed but shows from 500 to 600 lines. The coronium line is shown faintly, and will admit of a rough determination of position. A strip of continuous spectrum corresponding to the middle of the cusp runs the whole length of the plate, with no absorption lines or bands except in the ultra-violet where the image is weak.

A number of exposures made on other plates before and after totality are too much overexposed to be of any value.

Mr. Darling's account of the impression made upon him by his view through the four inch telescope is given below.

Professor D. W. Morehouse has kindly sent us copies of some of his excellent photographs of the corona taken at Matheson, Colorado. Plate XVII gives a fair reproduction of one of these and on the first cover page of this number of POPULAR ASTRONOMY will be found a more contrasty print from the same negative. Comparison of these plates with Plate XIV in our May number will show the marked change in the form of the corona.

The following communications, excerpts from letters, and preliminary reports concerning the eclipse, which have been sent in, in response to our request, will be interesting to many of our readers. The fuller reports by Professor Frost, Professor Slipher, Professor Miller, and Professor Edison Pettit will be found in separate articles.

AT CHEHALIS, WASHINGTON.—June 8 was unfortunately cloudy here at Chehalis, just a thin hazy cloud that covered the whole sky. The sun shone far too bright, however, for naked eye observation but the stars failed to show during totality and the corona was dim.

We were at first quite disappointed but as the weather looked no worse at 2:30 p. m. (summer time) we smoked a few glasses and started out, arriving at a point about two miles south of Chehalis at 3:10.

At a glance we saw the sun was partially eclipsed at that time. The moon covered possibly one-third of the sun's disc, and its slow advance was a grand sight through the smoked glass. When the sun was more than half covered (it then looked like a beautiful crescent) a queer darkness, different from twilight, began to cover the earth very slowly. At 3:50 it was quite dusk. We noticed how much cooler the air was and a sparrow flew aimlessly over the bushes nearby as if it did not know where to go. Other birds sang their evening songs once or twice. A cow in a nearby field lay down but did not bawl or seem worried in the least. My sister watched a hen with chickens.

At 3:55 (totality began less than half a minute afterward) the western sky was as black as the blackest thunder-cloud while in the east it was quite light. did not expect the shadow to come upon us as it did a moment later, in waves. Each wave, about a second apart they seemed, left the landscape a little darker. It would get no darker for another second or two then another darker wave would come upon us instantly and moving at an awful speed. We all noticed this. Then totality began before we knew it. The next minute and a half I will never forget to the last day of my life. How I wished the sky was perfectly clear! But even as it was, delicate colors fringed the sun, one that we noticed especially, a bright red "spark" on the upper eastern edge. It was brighter than anything else during totality. Probably a storm in the sun's chromosphere.

I am sorry to say I do not remember at what angle the corona extended from the sun but am almost sure it extended parallel to the moon's direction of motion.

The hen and her chicks went to roost but at the first peep of sunlight came out again. Then slowly it grew brighter. This was my first solar eclipse and I don't expect to see another, but it was the grandest sight I have ever witnessed even though a little cloudy. I hope to see some good photographs later.

EARL SHELDON.

Centralia, Wash.

LICK OBSERVATORY AT GOLDENDALE, WASHINGTON—"By a miracle we were able to carry out our full program."

W. W. CAMPBELL.

NAVAL OBSERVATORY ECLIPSE EXPEDITION AT BAKER, OREGON.

1. The longitude and latitude of the station were accurately determined.
2. The times of contacts were observed.
3. Five exposures were made with the 65-foot photo-heliograph as follows: (a) 5 secs. (b) 15 secs. (c) 35 secs. (d) 15 secs. (e) 5 secs.
4. Three exposures were made with the 105 inch camera as follows: (a) 15 secs. (b) 50 secs. (c) 25 secs.
5. Two exposures were made with the 33-inch camera as follows: (a) 65 secs. (b) 40 secs.
6. Six exposures were made with the 21-foot grating spectroscope as follows: (a) 7 secs. for first flash. (b) 5 secs. (c) 65 secs. (d) second flash. (e) and (f) instantaneous exposures after second flash.
7. Six exposures were made with the 10-foot grating spectroscope as follows: (a) 5 secs. for first flash. (b) 5 secs. (c) 80 secs. (d) 5 secs. (e) second flash. (f) instantaneous exposure after second flash.

8. Four exposures were made with the 64-inch grating spectroscope as follows: (a) 5 secs. for first flash. (b) 90 secs. (c) 5 secs. for second flash. (d) instantaneous exposure after second flash.

This spectroscope was used by Dr. P. W. Merrill of the Bureau of Standards, with films stained with dicyanin to photograph the spectrum to greater wave-lengths.

9. A careful study of the corona and other features of the eclipse with a drawing showing the colors in different portions was made by Mr. H. R. Butler, a prominent artist of Princeton, New Jersey, and a volunteer member of the party. Immediately after the eclipse, Mr. Butler made a careful painting of the eclipse.

A thin cloud or haze covered the sun at totality and obscured the faint portions of the corona. The photographs show the many beautiful prominences and the corona as far out as half a diameter or perhaps somewhat more. The spectrograms show numerous lines. No careful study has yet been made of either plates or spectrograms. A more complete report will be published later.

J. C. HAMMOND.

[Communicated by T. B. Howard, Rear Admiral, U. S. N. Ret., Superintendent.]

MOUNT WILSON OBSERVATORY, GREEN RIVER, WYOMING.—The afternoon of the day of the eclipse at Green River, Wyoming, was marked by cumulus clouds in a sky of remarkable transparency. At first contact the sun was entirely clear, but shortly afterward a thick cloud covered its disk. This thinned somewhat during the total phase, especially near the end, but at no time during totality was more than a fraction of the coronal light available. The brilliant prominences surrounding the sun were readily visible during much of the total phase, but the outer corona could not be seen with certainty. Within a few minutes after third contact the cloud passed completely and the sun was no longer obscured.

The program of observations was carried out as planned, and the development of the negatives showed that more results had been obtained than was expected under the conditions. Of the direct photographs secured with the 30-foot photo-heliograph all four showed excellent detail in the corona and prominences, that taken with the longest exposure being of especial value. The single photograph made with the short focus lens of large angular aperture was also successful. A negative secured with a short focus quartz lens silvered on both surfaces, showed a solar image of considerable density.

The spectroscopic observations, as would be expected, were interfered with greatly by the cloudiness at the time of the total phase. Some valuable results however, were obtained with the concave grating objective spectrograph, a large number of lines being photographed in the spectrum of the prominences and the upper chromosphere during totality. The negative secured with the prismatic spectrograph, designed for the purpose of determining the rotation of the corona, showed a faint line on one side of the solar image in the position of the green coronal line. Although no observations of rotation can be made, measures already completed yield an excellent value of the wave-length of this important line. Some photographs made to test the polarization of the coronal light also proved to be partially successful.

WALTER S. ADAMS.

ROCK SPRINGS, WYOMING.—We had extraordinary luck at Rock Springs, as a clear space came just two minutes before totality, and our program was carried out. I hope to send you a little article for POPULAR ASTRONOMY with several illustrations, but in the mean time, you can say that we were among the lucky ones.

JOEL STEBBINS.

FRASER, COLORADO.—The writer viewed the total eclipse of June 8, simply as a spectacle, from the mountain village of Fraser, Colorado.

It was a more or less selfish aim, the gratification of a curiosity, that led me to take the long journey, but it must be admitted that such a curiosity needs no apology. Other observers, however, the real astronomers, were willing to forego the pleasure of watching the wondrous sight, in order to obtain precise data which would add to our knowledge of the great luminary and its surroundings. To these men is due much credit from all who appreciate the value of scientific discovery. It was my good fortune to accompany a party of such observers, consisting of Professors Leavenworth and Beal of the University of Minnesota and Professor Wilson of the Goodsell Observatory of Carleton College, Northfield, Minn., all from my own state. The work of these astronomers with cameras and spectrograph will, I trust, be fully reported in POPULAR ASTRONOMY.

The tube of a 4-inch Gaertner refractor brought by Professor Leavenworth was at my service during the period of totality, while the clock-driven mounting was used to carry the cameras. The tube was given a temporary support and was provided with a crude but fairly effective slow-motion device. A low power was used, 40 diameters I believe, giving a field of about twice the sun's diameter. Professor Wilson used this telescope for observing the first and fourth contacts. The writer used it for noting the second and third contacts and calling off the times for the observers.

Immediately after the second contact the dark glass screen was laid aside and there burst upon my view the orange-colored chromosphere, and rose-pink prominences of various sizes and forms and of curious detail, surrounding the black round disk of the moon. These as viewed through the telescope, and with the bright white coronal light for a setting, formed a picture of indescribable beauty. Several large prominences like mountains of flame extended outward into the corona to a distance of perhaps one-tenth of the moon's diameter or from 75 to 100 thousand miles above the sun's surface. One or more of these prominences were plainly visible to the naked eye. One tree-like prominence on the westerly edge of the sun, with horizontally spreading branches, delicately and distinctly outlined, impressed me with its beauty.

The forms of the prominences were generally of types which have heretofore been observed and described, as far as my very brief view enabled me to judge, but no description I have read conveyed to my mind on adequate conception of the richness of coloring shown by actual vision. The Elysian fields of classical mythology might find a fitting representation in the entrancing picture presented within the telescopic field. Gladly would I have watched and studied the details of the prominences during the entire brief minute and a half of totality, but this could not be as other things were on hand.

The corona was best seen with the naked eye. It was much brighter than I expected to see, probably for the reason that I had in mind the fact that a photograph with long exposure of a faint object like a nebula is impressed upon the plate far more strongly than the same object can be seen by direct vision or with telescopic aid. Its general appearance conformed with some previous photographic views, particularly with one taken by Professor Wilson in 1900 and reprinted in POPULAR ASTRONOMY of May 1918. Its brilliancy was indeed a surprise. I noticed three prominent coronal extensions, but time was too brief for sketching; besides I did not think it worth while to try to compete with the more truthful photographs which I believed would be obtained.

Vainly I watched the distant western mountains and valleys, before totality to see indications of the approaching lunar shadow, and of the receding shadow after totality. The curtain of clouds which covered probably 95 percent of the entire sky was what deprived us of that anticipated spectacle.

During totality the darkness was pronounced and gloomy it undoubtedly was intensified by the cloudiness which shut off from the surrounding country much of the coronal light. Off in the southwest was some clear sky, and there I saw what appeared like a twilight, strong near the horizon and diminishing in brightness with altitude. This light I suppose was the illuminated atmosphere beyond the lunar shadow which was at least a distance of about thirty miles from us. After the eclipse was over a maid told us that the chickens at the hotel went to roost as the darkness came on, or rather that all but one of the seven chickens did so. I believe the girl reported truthfully. It did not appear whether that one chicken had obtained inside information about the eclipse or was simply not in the habit of retiring early.

From this experience I would say that a total eclipse is worth going a long way to simply look at; provided of course a person has the means and is willing to take a chance on the weather, and further that he provides himself with a moderate sized telescope. The remembrance of the view will be an abiding pleasure.

J. H. DARLING.

Duluth, Minn. July 2, 1918.

BOULDER, COLORADO. The following private letter may be of interest to our readers in giving one person's impressions of a fortunate view, in the vicinity of Denver, of the recent eclipse.

The illusion of the whirling motion of the sun and moon seems a quite natural one when for the moment the raylike phenomena of the corona are revealed.

"We saw the eclipse splendidly. At 2:30 we started up Sanitas, a razorback mountain behind our house. It was very cloudy and thundering so that we expected a shower. The climb would have been tremendously hot in the sunshine. As we reached the last hill at 4:40 the clouds parted and we saw the beginning of the shadow. We went on to the top and watched the shadow over the snow covered Rockies to the northwest passing on over the plains to the east below us. The glorious beauty of the full eclipse is far beyond words. The clouds remained parted until the eclipse was entirely over und then they closed the gap and we went down in their shadow.

"I am sorry to say that the people of Denver could see nothing for the city was all covered with clouds. We could see a rain-storm over in Wyoming at the time. As we climbed our mountain, the Rockies and the plains were bathed in sunlight, while we were in the shadow of the clouds. The eclipse shadow seemed all the more pronounced after the previous sunshine.

"The glorious colouring of the clouds in the east will remain with me always. During the totality the moon and sun seemed to be each whirling around. The roosters crowed in the valley. We had the best of places to see.

"It was a precious opportunity to see a bit of the wonders of God's universe, I have never experienced anything which caused that which we call death to seem so easy and simple. It all seemed to pass before me in my imagination as such a beautiful thing after all.

"I wish I could tell you more of the eclipse but I do not seem to know how. How glad am I to have seen it."

(MRS. R. L.) MARY M. VAN DEMAN.

Boulder, Colorado,
June 9, 1918.

MATHESON, COLORADO.—Mr. Pettit and I were able to observe the first and fourth contacts through my three-inch finder. At the beginning of totality there was a very thin veil of cloud over the preceding edge of the sun, but this disappeared and we had a very fine view of the corona. Our program was so arranged that we were able to observe all of the known phenomena occuring at the time of the solar eclipse. We observed all four contacts, Bailey Beads, the flash spectrum, which we obtained at both contacts, and the shadow bands, and secured six photographs of the corona.

I have developed three plates so far, and in my judgment they are very good. Indeed I feel that one is quite an excellent plate.

D. W. MOREHOUSE.

Des Moines, Iowa,
June 21, 1918.

SMITHSONIAN ASTROPHYSICAL OBSERVATORY EXPEDITION, BETWEEN HARTLAND AND LAKIN, KANSAS.*—Owing to other duties the expedition was more limited in scope than had at first been proposed. It included: (1) Observation of times of contact. (2) Visual observations of the phenomena. (3) Pyranometer measurements of the degree of brightness of the sun and sky during the partial phases, and of the nocturnal radiation during totality; both compared with similar observations of another day and night, and associated with humidity determinations. (4) Photography with two cameras of three inch aperture and 11 feet focus.

The expedition was in charge of L. B. Aldrich, who was assisted by A. Kramer and by Reverend Clarence Woodman of Berkeley, California, a volunteer observer who had aided in the observations of our party at Wadesboro, N. C., in 1900.

A place on the central eclipse line between Lakin and Hartland, Kansas, was selected for the observations. Messrs. Mauchly and party of the Department of Terrestrial Magnetism of the Carnegie Institution occupied the same station. They were on the ground first and were very kind to aid Mr. Aldrich's preparations.

After cloudy and rainy weather during the whole week, which prevented any focus exposures or the careful rating of the driving mechanism of the photographic apparatus, Saturday afternoon and evening of June 8 were generally fair. The eclipse was observed with complete success. and was an unusually grand sight visually. The darkness was unexpectedly great.

Reverend Clarence Woodman reported contacts as follows:

Latitude	37°	53′	04″.2 N
Longitude	101	17	51 .3 W

Contacts. Greenwich mean time.

First	10^h	19^m	$48^s.5$
Second	11	27	15 .1
Third	11	28	37 .3
Fourth	12	29	45 .4

Mr. Aldrich, with the assistance of Mr Kramer, observed with the pyranometer and wet and dry thermometers from 1 o'clock P. M. of local time to 10 o'clock at night on June 8 and again on June 9. Among many other observations made, the light of the whole sky, excluding the sun, was measured with the pyranometer within 1 minute of the totality both before and after. It proved at these moments to be equal to that of twilight 3 hours, 15 minutes later. The nocturnal radiation measured during totality was nearly two times as great as the nocturnal radiation at 10 P. M., but presumably so because the temperature of the radiating surface during totality exceeded by fully 10° F its temperature at 10 P. M.

* Published by permission of the Secretary of the Smithsonian Institution.

The two cameras were mounted on a single equatorial asxi and were driven by clock work through a long arm. Equal exposures of 70 seconds for each camera were made by Reverend Clarence Woodman. The plates were very finely developed at Harvard College Observatory, by Mr. King with Professor Pickering's permission. Excellent photographs showing coronal extensions of several solar diameters were obtained.

Mr. Aldrich went on to Mount Wilson for the summer solar-constant work immediately after the eclipse, and his detailed report will be made later.

C. G. ABBOT.

MCALESTER, OKLAHOMA.—The writer was fortunate enough to get a clear view of the eclipse at McAlester, Oklahoma, and notes on the appearance there may add a little to the sum total of the phenomena elsewhere observed. McAlester is in latitude 34°, very nearly, and only about five miles inside the southern edge of the totality belt. The eclipse was scheduled to begin at about half past five, central summer time, with totality lasting abour thirty-five seconds, beginning at 6:33-34. No attempts were made to check these times. There had been rain the previous night and the sky continued heavily clouded through most of the afternoon, finally breaking away into light alto-cumulus as the eclipse came on. The gradual fading of the light was obvious, but not particularly striking until its rapid failure just before totality. About five minutes before totality the light clouds, slowly drifting eastward, cleared away and left the sun in a fairly clear sky for the next quarter of an hour. The light now faded very rapidly as the sun was diminished to a narrow crescent. No trace of shadow bands was visible, but the shadows themselves took on the customary extreme sharpness and hardness to be expected. I was provided with a dense neutral glass, peculiarly non-selective in its absorption, and a Wratten "mercury green" screen, No. 62. Watching the fading area of light through the former I lowered it as the last beams were fading and caught the corona a few seconds before the last blaze of light disappeared from the sun's limb, which it did without any visible trace of color. The corona was fairly evenly distributed around the sun with a few horns of moderate extent, particularly in the upper portion, extending 10 to 15 minutes of arc from the sun's limb. The sky was not clear enough to observe any faint outlying parts of the corona, if such there were.

Jupiter was plainly visible to the eastward of the sun, but the light was that of only a moderate twilight in which the stars are just beginning to be visible. The leaves of a nearby tree looked a peculiarly vivid green. The visible color of the corona was a pearly bluish-white, as generally described, reminding me very strongly of the color noted on direct observation of a quartz mercury arc, which, like the corona as here noted gives a strong green cast to objects by which it is somewhat faintly reflected. I have in fact seen the tube itself with its characteristic bluish white hue, and in the same field of view the reflection of it from a distant window pane, which exactly matched the green of the grass outside against which it showed. The characteristics of the gaseous spectrum of the corona fully account for this similarity, the predominant features being the green coronal line and the blue and violet, chiefly chromospheric lines, associated with it. At all events the resemblances in color and light effect between corona and quartz arc are very noticeable.

Observing the corona through the Wratten screen it stood out vividly against the darkened background, apparently relatively much brighter than when unscreened. and I should judge slightly more extensive.

At the first flash of the emerging sun I shifted to the neutral glass, and for a few brief moments got the emerging limb of the sun of a vivid crimson. In shifting, the corona was still visible a few seconds after the close of totality. The

crimson flash was a real phenomenon, as I later tested for possible contrast effects due to the green screen, and found them negligible. A few minutes later thin clouds swept over the sun and the period of emergence was quite without interest.

LOUIS BELL.

Boston, Mass., June 26, 1918.

COCOA, FLORIDA.—After several years of obtaining cloud observations throughout the extent of the eclipse track, we did not after all go to the regions which promised most cloudless skies. The war and other considerations caused us to remain in Florida instead of taking a long journey to the west, and we went up the east coast to this little town, hoping that the probability of cloud here might not be fulfilled.

We find a pleasant little village situated on the Indian River, with an appearance of sub-tropical summer weather. The long bridge over the river and many small boats give the usual appearance in Florida of the constant sea life. The inhabitants were aware that the eclipse was to come. The little paper had had a very good editorial on the subject and we found ourselves known on our arrival.

The eclipse here would be 20 seconds shorter than farther down at Eau Gallie, but other considerations induced us to think that Cocoa might be preferable. We had engaged the owner of one of the small yachts here to run down about fifteen miles with us to the point of greatest length in eastern Florida. At the time when it was necessary to start, however, a thunderstorm had covered all the sky with black cloud, and the incessant flashes of lightning decided us to remain here.

As the afternoon wore on, the clouds lifted a little and we decided to cross the long bridge to Merritt's Island where there was a good horizon toward sunset. The numerous piers which the island folk had built long years ago made a roosting ground for many kinds of water birds, and shoals of fish made constant breakings of the surface. As the day drew on toward eclipse time, it became suddenly very dark in a more intense and portentous way than could be accounted for by the approach of sunset or the heavily clouded sky. In three distinct jerks the entire darkness came on behind the clouds. No sight of the corona was possible, and the colors along the horizon were much less gorgeous than I have seen in other cloudy eclipses, especially in Japan in 1896. When it was darkest a *chuck will's widow* began his mournful midnight song, and that was the only sound during the impressive darkness. For only a little more than half a minute it continued and then there was a sudden lightening of the landscape and totality was passed. A moment or two afterward the tiny crescent of true sunlight appeared through a rift in the clouds, but was speedily engulfed, and all that we have of the 1918 eclipse was a memory.

MABEL L. TODD.
DAVID TODD.

June 8, 1918.

TOTAL SOLAR ECLIPSE, JUNE 8, 1918.

EDWIN B. FROST.

An expedition from the Yerkes Observatory was authorized by the President and Trustees of the University of Chicago, after a preliminary inspection of sites had been made by Professor Barnard and the writer (POPULAR ASTRONOMY, Vol. XXVI, February 1918). As the plans developed, the Observatory was interested in three stations: (1) At Green River, Wyoming; (2) at the Chamberlin Observatory of the University of Denver; (3) at Matheson, Colorado. At the last-named point a station was set up by Professor Edison Pettit of Washburn College, Topeka, who has been an Assistant at the Yerkes Observatory during the first half of 1918. He was assisted by Miss Steele, Fellow in Astronomy, University of Chicago, by Miss Gushee, and others. Most of the apparatus used belonged to the Washburn College Observatory, although some was supplied from here. Mr. Pettit gives elsewhere a full account of the expedition and pictures showing the excellent results obtained, so that further reference need not be made to it here.

In accepting the offer of Director Howe of the Chamberlin Observatory and the authorities of the University of Denver, that we should make use of the 20-inch equatorial, it seemed best to employ the instrument with a spectroscope. The autocollimating spectrograph which has been used at times with the 40-inch telescope, particularly for the visual region of stellar spectra, was accordingly adapted so that it could be attached to the drum provided by Saegmuller on the 20-inch equatorial for such a purpose. A Michelson grating concentrating much of the light in the first order was used with a lens of 30 inches focus. Professor Schlesinger of the Allegheny Observatory very kindly loaned the attachment used on the Porter spectrograph at that observatory for bringing into the central part of the slit light from the east and west limbs of the sun. This consisted of a mounting carrying diagonal prisms and described in the Publications of the Allegheny Observatory (Vol. 3, p. 303). The writer spent the week from May 27 to June 2 at the Chamberlin Observatory in getting this apparatus into proper adjustment. Professor R. S. Nyswander of the University of Denver kindly agreed to operate this instrument at the time of the eclipse and took part in all the work of adjustment. It was proposed to set the diagonal prisms so that light would be taken from points about two minutes east and west of the sun's equator for determining,

if possible, the rotation of the corona. The scale was not very large, about 22 A per mm, and the trial plates covering the region of the spectrum from G to the D lines gave promise of yielding satisfactory results. The totally cloudy condition of the sky at Denver prevented any observations from being made.

To provide for the direct photography of the corona at Denver, a small coelostat was adapted in our shop from a small equatorial telescope, which had been loaned to the Observatory. This carried an 8½ inch plane mirror, loaned by the Mount Wilson Observatory, and a 6½-inch mirror, the normal to which pointed slightly farther west. This coelostat fed a five-inch visual objective intended as a finder for the 20-inch equatorial, having a focal length of about 22 feet. Trial exposures with this lens by Professors Howe and Nyswander gave good photographs of the moon, showing that the lens would perform satisfactorily for the purpose. The instrument was erected a few rods away from the Chamberlin Observatory and was operated by Professor Paul Biefeld, of Denison University, who volunteered his services and set up the instrument and oversaw the construction of the wooden tube of this horizontal telescope. Good definition was obtained with the trial pictures on days prior to the eclipse and excellent photographs would doubtless have been secured if the weather had permitted. The smaller mirror fed a prismatic camera, consisting of a good flint prism and the apochromatic planar lens ($a = 2$ in., $f = 12$ in.) used in the sky patrol at Yerkes Observatory. This was to be operated for photographing the coronal rings by Frederick Leonard, graduate student at the University of Chicago.

The main station of the Observatory was at Green River, Wyoming, and the advance guard of our party, consisting of Professor Barnard and Miss Calvert, together with Mr. Foote, our carpenter, and Mr. Dahlstrom, our gardener, arrived there on May 4. The principal instruments to be used were the coelostat carrying two mirrors of 15 inches aperture and 10½ inches aperture, respectively. The smaller mirror fed a 6-inch lens of 60 feet focus, set up horizontally, terminating in a large dark room in much the manner as the apparatus was used at Wadesboro in 1900. Exposures with this instrument were made by Miss Calvert, under Professor Barnard's supervision. The "Kenwood" equatorial of the Yerkes Observatory was transported to Green River, with its 12-inch photographic objective. This was arranged for direct photography by Professor Barnard, with the use of 10x12 plates.

During the first few weeks, while the camp was being established, the weather was very unfavorable. In fact, it would seem that the latter part of May was characterized by unsettled weather through a great part of the track of the eclipse in the western states. The day of the

eclipse was particularly fine until clouds came up after noon; they had reached the sun at the time of first contact. It was a matter of anxious speculation whether they would drift past the sun before totality. As a matter of fact they did not, although the sun was entirely clear three minutes after totality. However, we enjoyed a fine view of the corona and the remarkably brilliant prominences through the passing cloud, and the photographs obtained show very much of interest, both of the corona and of the prominences. Pictures taken under Professor Barnard's direction will be published later, but they show in respect to the prominences an excellence of definition rarely equalled.

The 15-inch mirror, inclined about 8° to the west of the 10½-inch mirror, fed the spectroscopic apparatus as follows. (a) The small concave grating of 60 inches radius used without slit and intended for obtaining a record of the flash spectrum in the infra-red was operated by Professor Barrett, who dyed with dicyanin Eastman portrait films, 2x12 inches in size. The clouds were too thick to permit successful results with this instrument. (b) It was my plan to obtain a record of the successive changes of the chromospheric spectrum just before and after totality with the use of a moving picture camera. The three large Mantois prisms, which I had used at Wadesboro, were set up in a similar manner in front of a Brashear doublet of 40 cm focus and 5 cm aperture. This threw the image of the spectrum on the "movie" film, the short focus movie lens having been removed. This apparatus was operated by Mr. Blakslee, who turned the film at the rate of 16 pictures per second, beginning one minute before totality. During totality the motion was stopped in order to get the spectrum of the corona; the turning was resumed five seconds before the end of totality and continued for another minute. The apparatus worked very satisfactorily and would doubtless have given a very interesting record of the succession of changes undergone by the flash spectrum, which has been usually portrayed as a composite of the whole interval of one or two seconds involved. Of course a clear sky is essential for such delicate work, but in spite of this many hundred interesting spectra were obtained, some of which will be later reproduced. The light was not sufficient to give a good spectrum of the corona, although the prominences are well seen on the long exposure. (c) A small prismatic camera also took light from the same beam. It consisted of a Tessar lens of 305 mm focal length with a dense flint prism. This was operated by Professor E. C. Franklin of Leland Stanford University, who kindly offered his services. A strong spectrum, showing the coronal ring at λ 5303, was obtained.

(d) I myself intended to observe the flash visually, using a Rowland grating of 2 inches aperture with a visual telescope of 19 inches focal

length, and thus to give the signals for the other spectroscopic operations. The sky was not clear enough, however, for me to see the first flash and exposure had to be made from the time signals. I was also unable to see the green coronal line during totality, but after the second flash some of the reversed lines could be seen.

Observations were planned by Professor Parkhurst to cover the following points.

(a) Visual measures by himself with the Hartmann photometer of the general brightness of the corona.

(b) Photographs of the coronal rings for measurement of the intensity and distribution of the light within the corona, taken with a reflecting telescope of 6 inches aperture and 60 inches focal length, carrying our Zeiss U. V. prism of equal aperture and 15° angle.

(c) Photographs taken with the Zeiss U. V. doublet of 5¾ inches aperture and 32 inches focal length carrying the similar U. V. prism of 30° angle.

No precise results of the visual observations could be obtained through the clouds, but the color of the corona was much too blue to be compared with the tungsten standard lamp burning at full candle power, and the tint was a little stronger than the light of the same lamp through a blue filter. The light of the tungsten lamp was itself so blue that its candle power measured with blue light was more than double its visual candle power.

With the reflector, three exposures were made, which gave strong images of the coronal ring at 5303 and others. Numerous sharp images of the prominences were also shown on these plates.

The two exposures with the doublet were somewhat over-timed, but exhibit much the same features as are shown by the reflector.

The exposures with the reflector were made by Miss Wickham; with the doublet, by Miss Lowater. Mrs. Parkhurst acted as recorder for the visual observations.

The direct photographs of the eclipse were undertaken by Dr. Isham with a "Universal" moving picture camera. For its lens was substituted a Voigtländer Euryscope of 4 inches aperture and 25 inches focal length. Satisfactory pictures were not obtained with this instrument, however. We are also indebted to Dr. Isham for the use of the other "Universal" camera employed for the flash.

It was not found possible to use at this eclipse the interferometer which was kindly offered by M. Fabry, being the instrument with which he and MM. Buisson and Bourget made interesting studies of the motions within the Orion nebula. I have in fact just received notice that the instrument reached Washington in July.

It seemed to be advisable that use should be made of the collimator of 42 inches focus which we used at Green River for adjusting our spectroscopic apparatus, and therefore I requested Dr. C. C. Crump, of Ohio-Wesleyan, who joined our party at Green River, to operate it for the flash spectrum and the coronal spectrum. For the purpose I carried an extra 4-inch Rowland grating and camera, also of 3 inches aperture and 42 inches focus. The adjustments could not be completed until the last day because of the need of the collimator for other purposes, but it was in order at the time of the eclipse and was fed by our Brashear heliostat. This was operated by Professor L. A. H. Warren of the University of Manitoba, who used a small theodolite to throw the point of the cusp upon the proper part of the slit, using the slow motions attached to a vertical plane mirror which received the light from the heliostat. Owing to the state of the sky these observations with the slit spectrograph were unsuccessful.

Time was called by Professor H. R. Kingston, of the University of Manitoba, who, with Professor Warren, had spent the week prior to the eclipse with us and assisted in various ways.

A considerable measure of the success obtained by our expedition at Green River was due to the untiring efforts of the staff, including Mr. Romare, our instrument maker, and to the cordial coöperation of many citizens of Green River, particularly Mr. William Hutton, Jr., who rendered us most important assistance in a great variety of ways.

July 13, 1918.

THE LOWELL OBSERVATORY SOLAR ECLIPSE EXPEDITION.

V. M. SLIPHER.

In selecting a station for the Lowell Observatory Eclipse Expedition consideration was given to: (1) accessibility to the Observatory; (2) distribution of the expeditions along the eclipse path, and (3) the observing conditions to be expected of the locality. The first two conditions were well satisfied by a station near where the path of totality intersected the main line of the Sante Fe railroad in the western edge of Kansas and this locality was favorably regarded from the outset. This region is only one day's journey by train from Flagstaff, and possessed the obvious advantages that freight and express shipments

of apparatus could go through without change en route. Other expeditions except that from the Sproul Observatory, as far as we knew, were choosing locations from Matheson, a little way southeast of Denver, westward along the path to the Pacific Coast, thus leaving southeastern Colorado and western Kansas open. It had been early agreed with Professor Miller of the Sproul Observatory, that the two expeditions would coöperate as far as possible, and in consequence it was desirable that the stations be not very widely separated.

The Lowell station was chosen a few miles from Syracuse, Kansas, and the Sproul station at Brandon, Colorado. It was of course realized that in western Kansas the June rainfall is more than to the westward of Denver, and that the eclipse hour would be later with somewhat less altitude of Sun and the period of totality appreciably shorter than towards the Pacific Coast, but the matters of accessibility and better distribution of the expeditions along the path seemed compensatory.

The Lowell station was located about 8 miles north and 1 mile east of Syracuse, Kansas. During the two weeks preceding the day of the eclipse there were frequent showers and the sky was almost continuously cloudy, day and night, exceptionally so, we were told. These conditions interfered with preparations and seriously limited the opportunities for properly adjusting and testing the instruments. The unsettled weather occasioned much trouble through the warping of the wooden parts of the instruments and their mountings. The wind was often so strong as to be very troublesome in the preparations, although its interference had been anticipated and a valley depression in the plain utilized for the camp.

At sunrise on eclipse morning the sky was partly clear, but the clouds thickened rapidly and it was soon completely overcast. However, in the late forenoon the clouds broke and by noon the sky was mostly clear. During the afternoon patches of haze appeared and at eclipse time and during totality a thin cloud or mass of thick haze covered the region of the Sun. This cloud cut down the light generally and scattered the light of the brighter parts of the corona, and hence very seriously interfered with all smaller scale instruments for the recording of the outer parts of the corona. The large scale plates particularly of the inner corona and prominences suffered in a much less degree.

It was planned to take direct photographs of the corona and the region about the Sun with the following instruments:

Two objectives of 5 inches aperture and 38.7 feet focus, tower telescope mounting as first used by Professor Schaeberle, with exposures varying from ½ second to 45 seconds, for the brighter part of the corona and the prominences.

12″ reflector 100″ focus 5″ photographic doublet 35″ focus 6″ visual refractor 90″ focus 4″ visual refractor 60″ focus	With exposures varying from 5 seconds to 40 seconds, for extensions of the corona outside of the parts recorded by the long-focus tower telescopes.

Two lenses of 3″ and 3½″ aperture and 11 feet focus for recording the stars in the vicinity of the Sun. Exposure throughout totality. Two extremely rapid short focus lenses (Voigtländer f 2.3, Dallmeyer f 2.7) one exposure throughout totality, for the faintest extensions of the coronal detail and streamers.

In all twenty-six plates were obtained with these instruments, eight of this number being made with the long focus tower telescopes. The plates used were in most cases Seed 30. The visual refractors were used with color screens and Cramer's Iso Instantaneous plates.

The unfavorable sky conditions at the time of totality somewhat modified our exposure times from those planned on the supposition of a clear sky.

We were agreeably surprised to find upon the development of the plates that so much of the coronal detail had been photographed. But there can be no doubt that the fainter outlying parts and streamers had been largely obliterated by the haze and light clouds, and also that another effect was the scattering of the bright light of the inner corona as is shown by the appreciable amount of it that fell upon the disk of the moon.

The large scale photographs with the tower telescopes show well the brighter parts of the corona, and many prominences. In the longer exposures the coronal matter and streamers may be traced to nearly a diameter from the limb of the moon and much delicate detail was recorded. The more rapid, shorter focus, instruments bring out a somewhat greater extent of the corona but not so much as should have been expected under conditions of a clear sky.

The general shape of the corona is roughly triangular, the apex on the east and the base on the west side, and lies between the maximum and minimum types. The petal-shaped form of the coronal detail is evident on the west side, resulting from the rifts in the coronal matter and the directions of the fine streamers. There are many conspicuous prominences, some of them large. The arches of the coronal matter is very striking above practically all the brighter prominences, apparently showing the influence of the prominences upon the surrounding and superposed coronal matter and streamers. The apexes of some of the arches are visible at distances of half a radius from the sun's surface.

The spectrographic observations undertaken concerned the spectrum of the corona. Thus the instruments were such as could be arranged

from the stellar and nebular equipment of the Observatory, and of comparatively low dispersion. The results of the spectrum observations are briefly as follows:

I. Two exposures were secured with a single-prism slit spectrograph with short camera; one with the slit east and west near the south limb of the moon, the other with it north and south and farther from the moon's limb. These show the continuous spectrum of the inner corona crossed by the (prominence) emissions of hydrogen and calcium. Farther from the Sun's limb the solar absorption lines are present.

II. A plate with a single-prism instrument provided with a longer camera recorded the brighter corona from D_3 to near wave-length 3600. This plate contains many hydrogen, helium and calcium lines (H and K very strong) and the green coronal line, wave-length 5303.0 as well as some additional lines and a continuous spectrum throughout. The calcium and hydrogen emissions extend to the greatest distances from the Sun's edge. The scattering of the light of the brighter parts of the corona and prominences is so marked that the stronger emissions continue across the lunar image (slit east and west). The continuous spectrum is spread in a less degree.

III. Another spectrogram was secured with three-prism dispersion and a short camera covering the spectrum fron $H\alpha$ to $H\gamma$ with slit east and west. It shows the three hydrogen lines and the stronger helium lines of the region, the green coronal line wave-length 5303.0 (preliminary measure) and a few other (flash) lines.

IV. A slit-less instrument of three-prism dispersion was used for the coronal rings. The scattered light and its continuous spectrum interfered but the plate shows the green coronal ring and thus by inference the distribution of the coronal material around the Sun through comparison with the helium ring of D_3 and the hydrogen ring of $H\beta$ on the same plate. The distribution of the coronal material though showing many local variations is generally about equally abundant for fully 45° along to the north and south of the solar equator. At about these latitudes it appears to drop off rather suddenly toward the polar regions where it is much rarer. The irregularities of the coronal ring do not correspond with those of the hydrogen and helium rings, and thus there is no obvious correlation between the corona and prominences.

The eclipse party consisted of Mr. and Mrs. V. M. Slipher, Mr. and Mrs. C. O. Lampland, Mr. E. C. Slipher, Mr. Stanley Sykes, and Mr. E. C. Mills of the Observatory; Mr. George R. Agassiz, of Boston, Mass., and Mr. and Mrs. O. H. Truman of the University of Iowa.

The party was joined on eclipse day by Mrs. Percival Lowell who had most generously provided for the expedition in every way and constantly gave it her unfailing interest.

Mr. Guy Lowell, the Trustee of the Lowell Observatory, suggested that the Observatory should undertake the observation of the eclipse and had taken keen interest in, and assisted with the plans until he went to Europe on a Government war mission, and it is regretted that he could not return in time for the eclipse as he had hoped to do.

Acknowledgements are due Doctor J. A. Miller and Professor W. A. Cogshall for helpful council and the loan of apparatus, the Naval Observatory for the loan of the two forty-foot lenses and clocks, Mr. George R. Agassiz for a large objective, the Flower and Haverford Observatories for clocks, and to a number of residents of Syracuse for their assistance on eclipse day.

A more complete account of the expedition will be published later.

Lowell Observatory.
Flagstaff, Arizona.

THE APPLICATION OF SCHAEBERLE'S METHOD IN THE PHOTOGRAPHY OF THE CORONA AT MATHESON, COLORADO, JUNE 8.

EDISON PETTIT AND HANNAH B. STEELE.

The expedition of the Washburn College Observatory sent to Matheson, Colorado, to observe the corona on the eighth of June was equipped principally to photograph by the method first applied by Schaeberle at the Lick expedition to Mina Bronces, April 16, 1893. In this method the telescope is stationary and the plate is driven by clock-work.

The lens available was the 12-inch visual objective of 165 inches focal length stopped down to 4 inches aperture. This objective has been used both with and without color-filter for stellar photography, so that the character of its images was fairly well known. Even at 4 inches aperture considerable aberration was apparent at the best actinic focus, which latter differed from the visual focus by less than 0.1 inch.

Computation showed that at the time of the eclipse the image given by this objective would be 1.52 inches in diameter and would travel 0.662 inch per minute of mean solar time. After some experimenting with both screw and cable drive, carried out at the Yerkes Observatory during the winter, it was decided to adopt the latter method of propel-

ling the plate-carrier at Matheson. The driving clock employed was one used in the Warner & Swasey chronograph at Washburn,—an excellent mechanism.

The driving-clock having retaining power, as is customary in this type of instrument, it was necessary to take the driving motion from the drum-gear off on a second gear to which the driving drum was attached, instead of attaching the driving drum on the main-shaft as in Schaeberle's apparatus. With the gear available it was found that when the fly-balls were set at 0 the diameter of the drum required would be only 0.862 inches (minus the diameter of the cable employed). This was computed from the formula

$$d = \frac{15\, f\, t \cos \delta}{r\, \pi}, \qquad \text{(I)}$$

where d = diameter of drum required,
f = focal length of objective employed,
r = 206265,
t = time of revolution of the drum in seconds,
δ = declination of the sun at mid-totality at the place of observation.

This value (0.862 inch) of d is obviously too small, for any irregularities in the cable or variations in its flexure would be likely to affect the uniformity of the drive. However, by driving the plate-carrier by means of a movable pulley attached thereto, instead of from the end of the cable, the diameter of the driving-drum may be doubled. The latter plan was adopted, making the drum 1.724 inches in diameter.

After some experimenting with different kinds of driving cable, heavy braided iron picture-wire was selected as being flexible and having little elasticity. Taking into account the diameter of the cable, the resulting diameter of the driving-drum was 1.665 inch. This drum was turned out of steel shafting to exact diameter and fitted to the driving-shaft with a thumb set-screw.

The plates selected were 10″x12″ Seed 30s, hence the carriage and holder were constructed with these dimensions in mind. An aluminum plate 10″ square was provided with accurate brass wheels 1.5 inches in diameter, with rounded faces running in two V-grooves cut in cast-iron ways 22 inches long. On account of the position of the sun at the time of eclipse the entire weight of the plate and carriage was on the two wheels on the lower rail. It being difficult to mount the two rails exactly parallel, the two upper wheels were placed on short levers worked by springs by means of which they were kept against the upper rail regardless of their convergence or divergence, thus promoting uniform motion so necessary to good definition on the plate.

The aluminum plate was perforated at the center to provide for an eye-piece with which the preliminary adjustments of the apparatus were made. This plate-carrier and its attachments were mounted on rectangular frame of 2x4s bolted firmly together. An electric contact attached to the carriage worked a buzzer when it came to the middle of its travel, and a pointer attached to it moved over a paper scale, the unit of which was 0.662 inches, indicating the position of the carriage from the center of travel in minutes of time.

Before providing a mounting for the carriage and clock it was necessary to know the position in which it was to be fixed, which in turn depends on the altitude and azimuth of the line which the image describes in the focal plane at the time of eclipse. The latter may be computed from the following convenient formulae:—

$$\begin{aligned} \sin k &= \cos\phi \sin t \\ \cos a &= \tan\phi \tan k \\ \cot a &= \sin\phi \tan t, \end{aligned} \qquad \text{(II)}$$

where

k = altitude of the line,
a = azimuth of the line,
t = hour angle of the sun,
ϕ = latitude of the place.

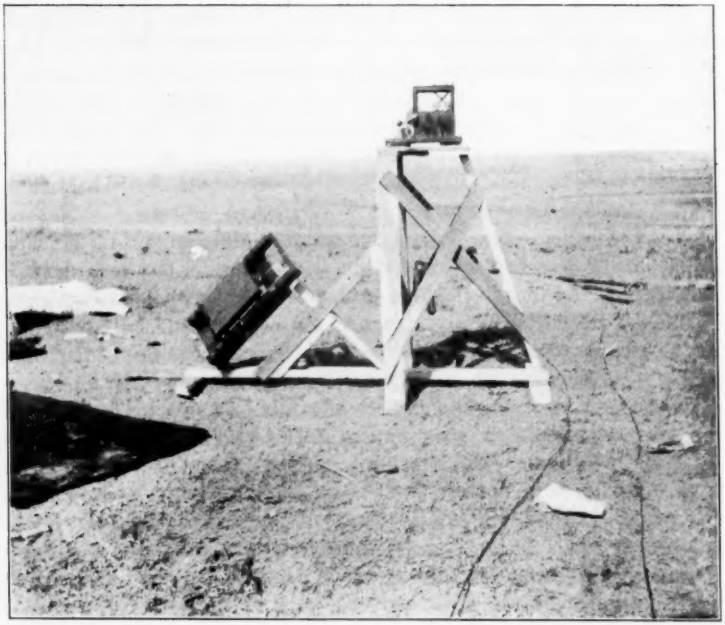


FIG. 1. THE PLATE CARRIER AND SUPPORTING FRAME.

In our case we found $k = 45° 49'.5$, $a = 33° 03'.4$ east. This line was chosen as the longitudinal axis of the plate and is the line parallel to which the rails of the plate-carrier track must be placed. Framework was then designed as shown in Fig. 1 carrying the plate-carrier and track in trunions at the above angle of 45° 49'.5 such that it might be rotated about the line of motion in order to collimate the plate, i. e., bring the plate perpendicular to the optical axis of the objective. Mounted in this way the whole framework could be set at the proper angle in azimuth and the plate collimated without difficulty.

Preliminary tests of the above theory were made at the Yerkes Observatory before shipping the apparatus to Matheson. After the apparatus was made, and on any given day when a test was carried out, there were two independent variables in formula (I), viz. f and t. Of these t also occurs in formula (II), and for practical reasons is the most convenient to choose for the test. Having chosen t, the values of k, a and f are determined for the day of the test. Since k is also fixed after the apparatus is constructed, the value of t to be chosen is computed from formula (II),

$$\sin t = \frac{\sin k}{\cos \phi}$$

and hence the value of f determined from formula (I). k can be slightly altered to suit convenience by blocking up one end of the framework, and this was found to be necessary on account of obstructions in the room where the test was carried out, which prevented the use of the computed value of t.

Having determined the above values, a card was attached to the window, with a hole a quarter of an inch in diameter in the center which would cast an image of the sun on the plate-carrier at the computed hour angle t, and the card and holder adjusted till their separation was equal to f. The azimuth was then adjusted by means of a magnetic needle and collimation of the plate adjusted by means of a mirror placed on the plate-holder. The latter was rotated on the trunions till the reflected beam returned to the hole in the card. A paper was then placed on the plate-carrier, the driving clock started and the image marked around. In this way the instrument was found to be in fair adjustment as far as this test would indicate.

Some points in the theory of the apparatus are pertinent here:—

1. The movable pulley attached to the plate-carrier must be as large and as accurately made as the driving-drum.

2. The wheels on the carriage must be accurately made and run smoothly.

3. The track ought to be curved. The deviation, however, is slight and for the exposures given may be neglected.

4. Both plate and objective must be perpendicular to the optical axis at the moment of mid-totality, and the image ought to be at the center of the plate.

5. The track must be exactly parallel to the equator.

II.

Matheson is a small village of about 50 inhabitants on the C. R. I. & P. R. R., 60 miles east of Colorado Springs, and suggested as a station by Messrs. Frost and Barnard after a study of the weather records of this vicinity, and a personal inspection by them in company with Professor Loud and others of Colorado College. For views of the landscape near the site see Mr. Frost's article in POPULAR ASTRONOMY XXVI, 103. The elevation of the eclipse site is 5950 ft. So far as known, no fundamental observations had been made for longitude and latitude at any point nearby, and our station was located by means of a Geological Survey map, the survey for which was made in 1890. After the construction was well along and the other members of the party had arrived, observations were begun with the Fauth sextant, mercury horizon and Bond chronometer to determine these quantities. The sextant reads to 10″ of arc, and the chronometer beats half seconds. As a result of three evenings' observations the longitude was found to be W 103° 59′ 00″, latitude 39° 10′ 33″ N. This is the same longitude as that indicated by measurement on the map, but the latitude is about a minute of arc greater. Hypsometer readings were taken frequently to determine the normal pressure, which seemed to be about 24.24 inches. An aneroid barometer gave the variations in pressure which were about 0.3 inches.

The members of our party, in addition to the writer, were Miss Hannah B. Steele, Fellow in Astronomy at the University of Chicago, Miss Vera M. Gushee, Demonstrator in Astronomy at Smith College, and Messrs. Finley F. Neal and Roy Owens, students at Washburn College, Topeka.

A dark-room 10 feet square was erected on a knoll about a mile and a half west of town and as nearly as could be estimated in the central line of totality. The building was rendered light proof by means of tar-paper held down by lath. Fig. 2 shows the construction of this building in the foreground. In the middle-ground is Mr. Chant's telescope house containing the 4-inch photovisual telescope, arranged for direct photography, and polarizing camera. Further on is Mr. Morehouse's station containing the 9-inch photographic lens of 10 feet focus and short focus camera. Nearby stood Mr. Loud's doublet apparatus. The chronometer table for the timekeeper and contact observer, stood by the barrel, which latter was struck with a hammer for signalling

the beginning and end of totality. The door of the house in the foreground is on the southeast corner, and the three telescope houses are in the meridian looking north. The C. R. I. & P. R. R. track is about a

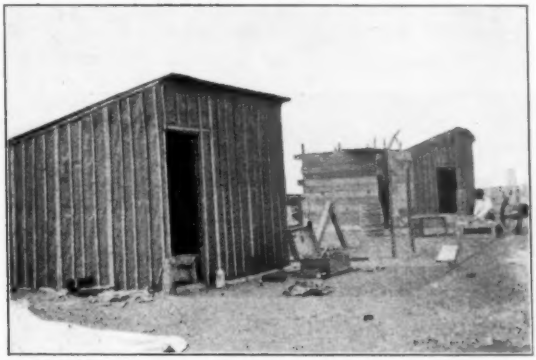


FIG. 2. "CAMP LANGLEY" MATHESON, COLORADO.

half a mile farther on. Pike's peak is visible due west (left of picture) on clear days. After the frame-work was erected it was shifted around till at 5:24 P. M. (eclipse time) the shadow fell directly back, i. e., the west side faced the sun squarely.

A tube 12 feet long, 22 inches square at one end and 14 inches square at the other was erected, painted black inside and covered with tar-paper outside. This was erected on the west side of the house, as shown in Fig. 3, the upper end resting on a rigid tower of 4x4s firmly implanted in the ground, and the lower end entering the building through

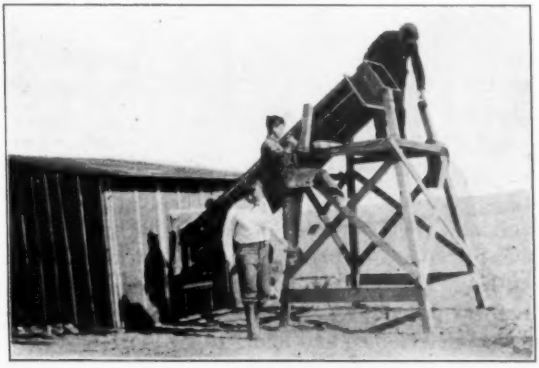


FIG. 3. ADJUSTING THE POSITION OF THE TUBE.

an sperture some 2 feet from the ground. A short tube containing the objective telescopes fits into the upper end of the larger tube and permits focussing of the apparatus. The upper end rests against a movable plank held to the tower by clamps. By shifting this plank toward or away from the tube, adjustment of the latter is made in altitude and the tube may be swung along it for adjustment in azimuth.

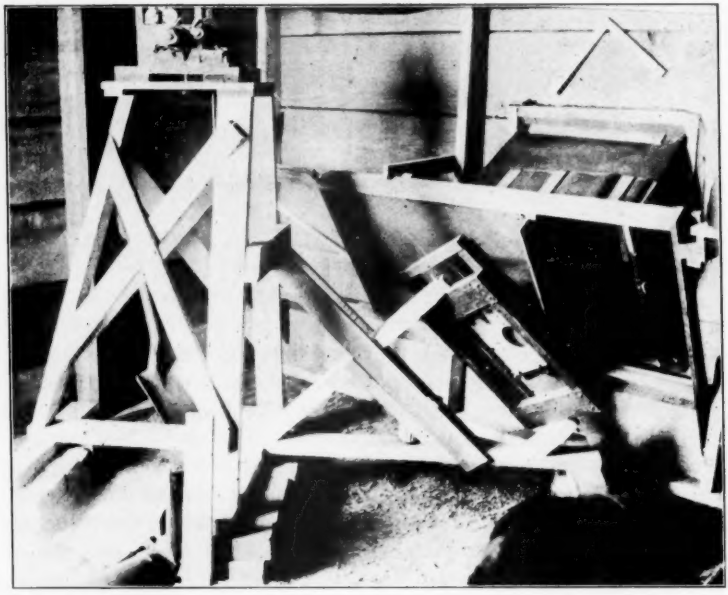


FIG. 4. INTERIOR OF TELESCOPE-HOUSE

Fig. 4 is a view of the inside of the telescope-house showing the lower end of the tube, focal plane shutter and plate-holder carriage as it was erected for use.

III

ADJUSTMENTS OF THE APPARATUS.

1. Preliminary orientation of the plateholder.

The framework shown in Fig. 1 was set by estimation in the approximate azimuth and in the focal plane by measurement from the position the objective was to occupy. The magnetic declination of the compass needle was then determined and found to be 14°.5 east of north. A copper wire was then stretched along the plank in the base of the frame-work, a compass placed beneath it with its N S line under the

wire. The instrument was then brought to the proper azimuth by turning it till the needle read the computed azimuth minus the declination just found.

2. Collimation of the plate and objective.

A silvered plate of glass with a triangular piece of paper pasted on it to mark the center of the plate was placed in the plate-carrier, and the carriage brought to 0 on the scale. An observer at the upper end of the tube (the objective not yet being in place) held a flash-light at the center of the opening. The carriage and track were then rotated on the trunions till the reflected image of the flash-light as viewed therefrom appeared at the center of the plate. When the objective was put in place it was collimated in a similar manner (save the use of the paper of course) from the aperture in the carriage from below, provided for the eye-piece.

3. Preliminary adjustment of the tube.

Before final adjustments of other parts of the apparatus were made it was necessary to place the tube in the proper altitude and azimuth line, and this was done before the objective was put in place.

A piece of heavy paper was placed over the end of the tube in place

FIG. 5. PRELIMINARY ADJUSTMENT OF THE TUBE BY MEANS OF A PINHOLE.

of the objective, as shown in Fig. 5, which illustrates this adiustment. In the center of this paper corresponding to the center of the objective, was a hole a quarter of an inch in diameter and below it a hole some

5 inches in diameter. Looking through this latter aperture down the tube, the image of the sun cast by the quarter-inch hole at eclipse time any clear day could be seen on the plate-holder below, 14 feet away. However, since the sun's declination would be less than on eclipse day, this image would always fall north of the center of the plate (by an amount easily computed) when the tube was properly adjusted.

On the day when the adjustment was to be made a plate of glass, the same size (10x12) as the dry-plates to be used, was provided with a disk of paper the same size as the image of the sun placed at the computed distance from the center. This was placed in the holder and the carriage brought to 0 on the scale. The standard time when the sun would have the same hour-angle as on eclipse day was then computed from the equation

$$t = T + E_o - E_e \qquad \text{(III)}$$

where t = the standard time when the adjustment was to be made,
T = the computed time of eclipse (mid-totality),
E_o = the equation of time on the day of adjustment,
E_e = the equation of time on eclipse day.

The observer placed himself at the upper end of the tube as in Fig. 5 and looking through the 5-inch aperture in the paper screen adjusted the tube so that the image cast by the quarter-inch hole fell on the paper disk at the instant t. The following day the operation was repeated from inside the telescope house having the objective in place. This method proved entirely sufficient for the purpose, although another had been provided. (The standard time when certain stars on the same parallel as the eclipsed sun would pass that point in the sky had been computed, and the surrounding B.D. fields plotted for identification. These were to be observed by a wide-field eye-piece attached to the plate-carrier at the aperture.)

4. Adjustment of the parallel.

A positive eyepiece with cross-wires attached was provided with a wooden mounting which, when the plate-holder was removed, could be put in its place. This consisted of a lever by means of which the eyepiece could be swung from side to side of the hole in a line perpendicular to the parallel of diurnal motion and the cross-wires be brought into the focal plane dictated by the plate surface and the difference between the visual and the actinic focus. At night a star would be found and brought on to the cross-wires when the plate carrier was at the lower end of its travel. Because the track was straight and the star loci curved, if the instrument were in adjustment the star would appear to rise to a certain height above the cross, reaching a maximum when the buzzer indicated that the center of the plate-holder was passing

the optical axis of the objective, and returning to the cross when the carriage came to the upper end of the track. This was found to be a very delicate adjustment and proved quite satisfactory.

5. Rate of the clock.

Here it was necessary only to secure a star as in (4) and adjust the fly-balls so that it would remain on the vertical wire throughout its travel.

6. Focus.

One of the chief difficulties in this method of photograghy is that of focussing. Exposure times are limited to the travel of the plate-carriage which in this case was about 14 min., and only such stars as were near the parallel could be used. The brightest of these were of seventh and eighth magnitude so it was seldom that the method of trails was available except at a couple of times during the night. However both methods were used and fair focus plates secured. Nevertheless with a smaller aperture this would be a serious matter, making it necessary to rely on measurement of the distance of the plate from the objective or the use of the focussing eyepiece.

We depended on the movable piece of tube containing the objective for the focussing of the instrument. However it was found that when this was done it was necessary to recollimate the objective. It would be better to have means of shifting the plate-holder perpendicularly to the carriage by means of screws to perfect the focussing adjustment.

IV

Additional Apparatus.

The spectroscopic apparatus and 5 foot camera were mounted in a tent outside. A polar axis of the "English" pattern was driven from a sector by means of a sand-clock made from a brass pump-liner. An objective-prism camera of 19 inches focus from Yerkes Observatory was used to secure the flash and coronal spectrum. A direct-vision spectroscope was placed on the same mounting to observe the spectrum visually.

A barometer (aneroid) was arranged to be read by means of a micrometer microscope at frequent intervals between first and last contact and was placed in the tent near the above apparatus. Messrs. Neal and Owens made the exposures and read the barometer.

V

Photographing the Corona.

Two things were involved in the program of photography of the corona.

1. Direct photography during totality on five 10x12 plates.

2. An attempt to photograph the corona before and after the eclipse, using an occulting-cup to keep the direct sunlight from the plate. So far as I am aware all previous attempts at extra-totality photography allowed the direct image of the sun to fall on the plate thereby subjecting it to great over-exposure and halation, which vitiates the results so far as the corona is concerned.

We intended to overcome the above objection by placing a blackened cup of tin, a little larger than the image, on the plate before exposure, so that the image would fall on this cup and only the corona and illuminated sky on the plate directly. The cup was 1.7 inches in diameter, having walls a half inch high and was stuck directly on the plate by means of chewing-gum. Three exposures were made before totality and one after, distributed as follows:—

Exposure	1	second at	5	minutes	before	totality—	Seed	30
"	10	"	" 2	"	"	"	"	"
"	14	"	" 1	"	"	"	"	"
"	40	"	immediately	following		"	"	"

The exposures made during totality without cup were as follows:—

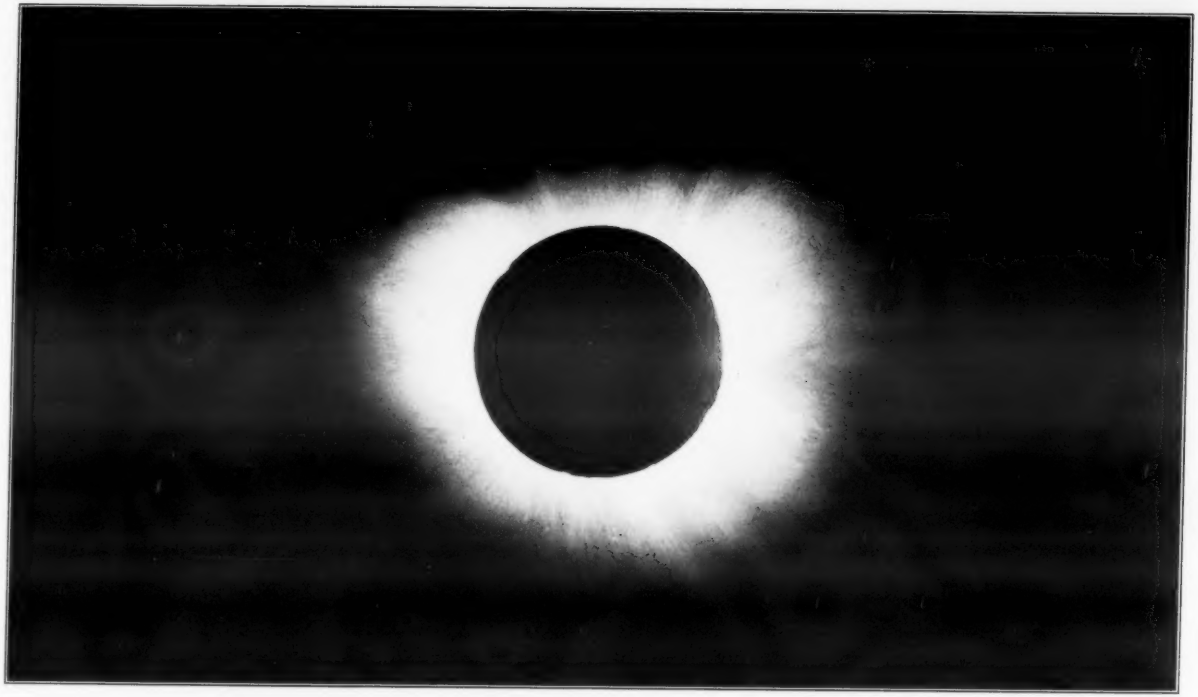
Exposure	1	second at	0	seconds	Seed	30
"	4	"	" 7	"	"	"
"	40	"	" 17	"	"	"
"	10	"	" 63	"	"	"
"	8	"	" 79	"	"	"

The 10x12 plates to be used were backed with Burnt Sienna and placed in a pile on a shelf protected from possible stray light on the right hand side of the plateholder, shown in Fig. 4. When totality was signalled, one of the observers (Miss Steele) standing by this shelf handed the plates to the operator (Pettit) who placed them on the carriage and made the exposure by sliding the focal plane shutter to one side. He then returned the exposed plate to the observer who placed them in another pile alongside the first.

On account of unavoidable delays, practice was not begun till Wednesday preceding the eclipse. Several practices were had at dusk so as to have the conditions as realistic as possible. The chronometer, which had been found to have a very constant rate, had to be stopped in order to repair one of the electric contacts. When started again the rate had the same value with the sign reversed. An electric circuit carried half-second signals to a sounder located in each observing-house for timing the exposures.

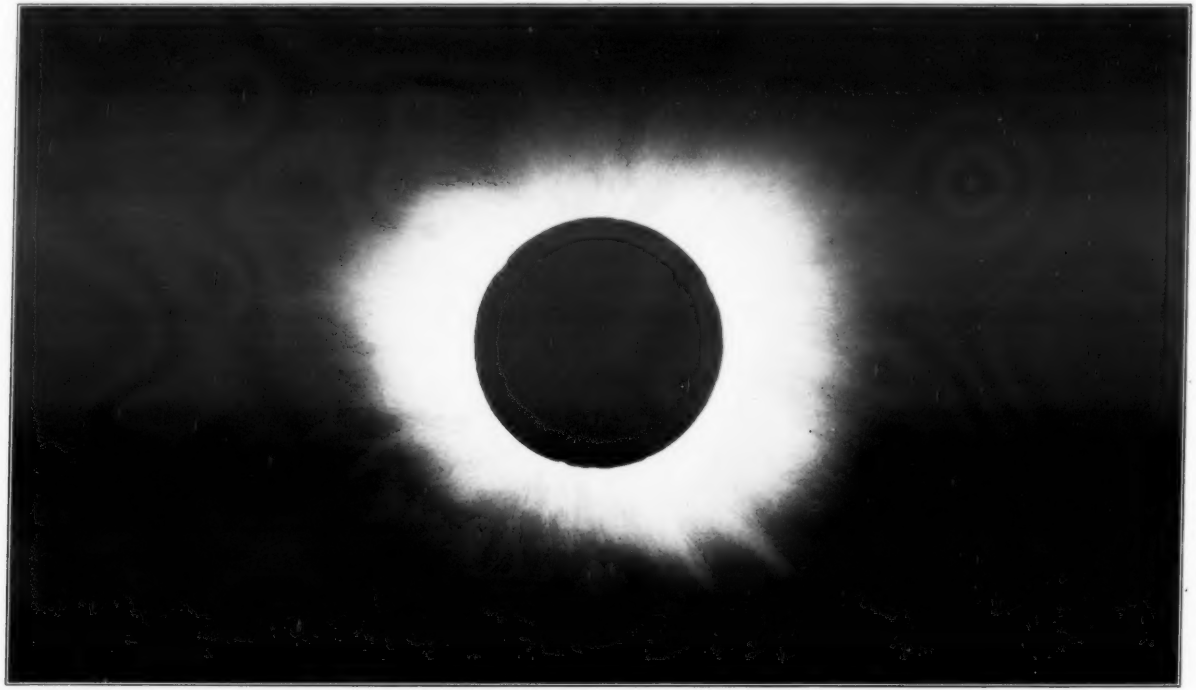
The program adopted was as follows:—Two observers were stationed at the chronometer—one to call the signals (Mr. Whistler, of the party from Drake University) and one (Miss Gushee) to observe the contacts

PLATE XVIII



CORONA JUNE 8, 1918, EXPOSURE 1 SECOND.
Photographed by Edison Pettit at Matheson, Colorado.

PLATE XIX



CORONA JUNE 8, 1918, EXPOSURE 40 SECONDS.
Photographed by Edison Pettit at Matheson, Colorado.

of totality. The signal observer called "time" 5 minutes before computed totality, and each succeeding minute. The signal "go" for totality was given by the contact observer the instant the corona came out, by striking the barrel with a heavy hammer. Immediately the signal observer took up the count, calling each second by the audible beat of the relay near the chronometer. The reappearance of the sun was signalled by the hammer on the barrel, indicating the end of totality.

Throughout our stay of three weeks at Matheson careful record was kept of weather conditions. The instruments employed were a thermograph, hypsometer, wet and dry bulb hygrometer, and barometer. Cloudiness and the visibility of Pike's Peak were recorded. One set of records was always made near eclipse time each day. The general conditions were normally about as follows:—The day would dawn clear or at least any visible clouds tended to disappear. Toward 11 A. M. large masses of cloud would begin to float over—the first indications of which appeared over the mountain range in the west. By 2 P. M. the sky would be well overcast and several thunder storms going around. Usually the worst sky was in the direction of the eclipsed sun. Often times clear sky would hit or miss the sun within ten minutes of eclipse time. Had the eclipse occurred near 10:30 A. M. the chances of clear sky would have been near 95 percent, but records showed that at eclipse time the chances were only 48 percent. We found, however, that when the wind was in the north the chances of clear sky in the afternoon were much better.

The second week of our stay was "stormy" preceded by heavy winds that lifted the sand and drove it into the working parts of any exposed apparatus. A box covered with oil cloth was made to cover the driving clock tight, but even then some sand made its way in. The greatest precipitation recorded at any time was 0.25 inches from a hail storm June 4. Many wonderful cloud effects were observed during this period.

Eclipse day proved no exception to our expectations. The previous night was clear, and we took advantage of it to improve the adjustments of our instruments. The sky had been clear at eclipse time the day before, so that a final check was had on the adjustments of the tube. On our return to the ranch-house at dawn the sun rose in a clear sky except for a bank of low-lying clouds in the south. A light breeze from the north brightened our prospects of a clear day. At ten o'clock the last chronometer check was taken from the Western Union line. The hygrometer indicated dry air and the north breeze still persisted. Low floating clouds had begun to stream along the mountain range and appeared in the north driven by the wind. The barometer was steady most of the day. Every one at the camp was busy getting apparatus in the best shape for the coming eclipse. A

wire fence had been put up to enclose the camp space, 60 feet wide and 150 feet long, to protect the observers from the sightseers. The spectroscopic apparatus was nearly completed but there remained some adjustments to be made. This was not completed till a half hour before eclipse.

By 3 P. M. the sky was well covered with dense masses of cloud and a heavy haze had spread over the western sky. Cars began to arrive from the ranch road in the direction of Colorado Springs, and by 4 P.M. there were about 150 ranged along the eastern side of the camp. A last practice was then gone through and final adjustments made. First contact was observed at 4:15:54 through thick creamy haze, by projecting the sun's image from the finder of Mr. Morehouse's telescope. The instant of contact proved very sharp, but was 7 seconds later than computed.

The thickening haze had darkened into a threatening storm-cloud. By 5 o'clock the haze around the sun had thinned a little but appeared to be moving slowly southward. A triangular shaped break in the haze some 20° on a side appeared in the north, driven slowly by the light breeze and seemed to be approaching the vicinity of the sun. The greenish gray light had begun to make objects take on a very peculiar appearance. Two men were sent out among the cars to request that no noise be made and that no lights be turned on till after the eclipse. This was repeated 10 minutes before totality. The triangular break in the clouds kept coming toward the sun, driven like clock-work by the north breeze. The time-keepers took their places at the chronometer table. A schedule had been made out for each so there would be no mistake at the vital time. This schedule contained the computed times of the signals and spaces for checking back the time of contact. After the contact observer had given the signal for first contact of totality she recorded as many times as possible the chronometer time corresponding to the count of the time-keeper. In this way the time of contact could be determined and several checks had on it. By observing the count corresponding to the last contact of totality, the time of this could also be determined.

Seven minutes before totality the cap was removed from the objective. The triangular clear space had nearly reached the sun and when we opened the focal-plane shutter to set the image on the carriage the crescent was projected on the holder through clear sky surrounded by a border of clouds, which were slowly breaking away. The sounder nearby was making a monotonous click each half second. "Time" was called 5 minutes before eclipse and our first exposure made with the occulting cup in place. Two more were made before totality. At 30 seconds before totality a plate was placed in the holder ready for

exposure, and the image on the shutter closely watched. The shutter being 14 inches from the plate, the image there was badly out of focus, but the instant of disappearance of the sun could be easily timed. From this observation the observer who gave the signal for totality was about 0.7 second late and 0.5 second late at the end of totality. The image of the eclipsed sun on the dryplate, as examined during the 40 second exposure, made a striking picture. The prominences were blood red—apparently much deeper in color than I have seen them in the spectroscope. The corona was a very pale green, some of the color of which may have been due to the yellow tint of the film on the plate. Its delicate filmy nature reminded one of the Great Nebula of Orion, yet the streamers were more of the nature of a miniature aurora except limb, that they were stationary. The large prominence on the upper left shown in Plate XVIII (seen inverted by me but erect in the plate), was by far the brightest feature of the eclipse. Persons who drew it from visual observations made it several fold too high, perhaps on account of its intense color and brilliancy.

The end of the eclipse was marked by a rapid brightening of the corona on the western limb. The effect was very similar to a sunrise on a clear day in midsummer except that the phenomenon progressed more rapidly. The corona was seen on the plate for the entire duration of the post-totality exposure of 40 seconds as it rapidly dissolved into the brightening sky. The streamers shown in the drawing (Plate XX) were the last features of the corona to leave the plate and stood out as the skeleton of its former self like a leaf after the ravages of the blight.

The plates taken before and after totality with the cup to shield off the direct sunlight failed to show any traces of the corona although the prominences are easily seen. I am quite sure that the corona before and after the total phase has too little contrast with the sky to be easily photographed. It is also apparent that what has heretofore been called corona on plates taken some time before or after totality is a spreading of the over-exposed image of the crescent sun or halation.

One of the most striking features of the corona, as shown on the plates, is its petal like formation. This feature is shown in the drawing (Plate XX). It will be noted that these petals are formed by the intersection of these streamers mentioned above. Old drawings show these petals like those of a lily. In all there appear to be seven of these petals. The streamer on the south-western limb can be traced a distance of one and a half million miles in a curved line.

Most of the petal forming streamers seem to be near the limits of the sunspot zones and those over the polar regions are straight. The corona is markedly unsymmetrical. At first sight it is of the "maximum" type on the western limb and "minimum" type on the eastern

limb, giving us a mixed corona. However, as will be noted in the drawing, the eastern limb corona also contains the petal formation though not so pronounced as the western. This state of affairs might be expected from the fact that the sun is now on the decline of the sunspot cycle.

The two large prominences on the eastern and western limbs are 56,000 and 45,000 miles high respectively. Over these and over one on the southwest limb may be seen arches in the corona. Those over the larger prominence are perhaps the most marked. Two prominences are almost exactly at the poles.

The thermograph showed a drop of 5°F during totality and the barometer a slight tendency to rise, though there is some uncertainty as to the latter.

The brilliancy of the corona must have been considerable. The observers in the tent needed no light to adjust their instruments or make the readings. The shadow-bands were observed by two of the party. These were said to be oriented in a northeasterly direction.

The time of first contact of totality was 1.5 seconds late and the duration 0.7 seconds less than computed.

Recognition must be here given to the kindness of Professor Frost for the use of the machine shop at Yerkes and to other members of the staff for many suggestions.

Yerkes Observatory,
Williams Bay, Wis.
June 28, 1918.

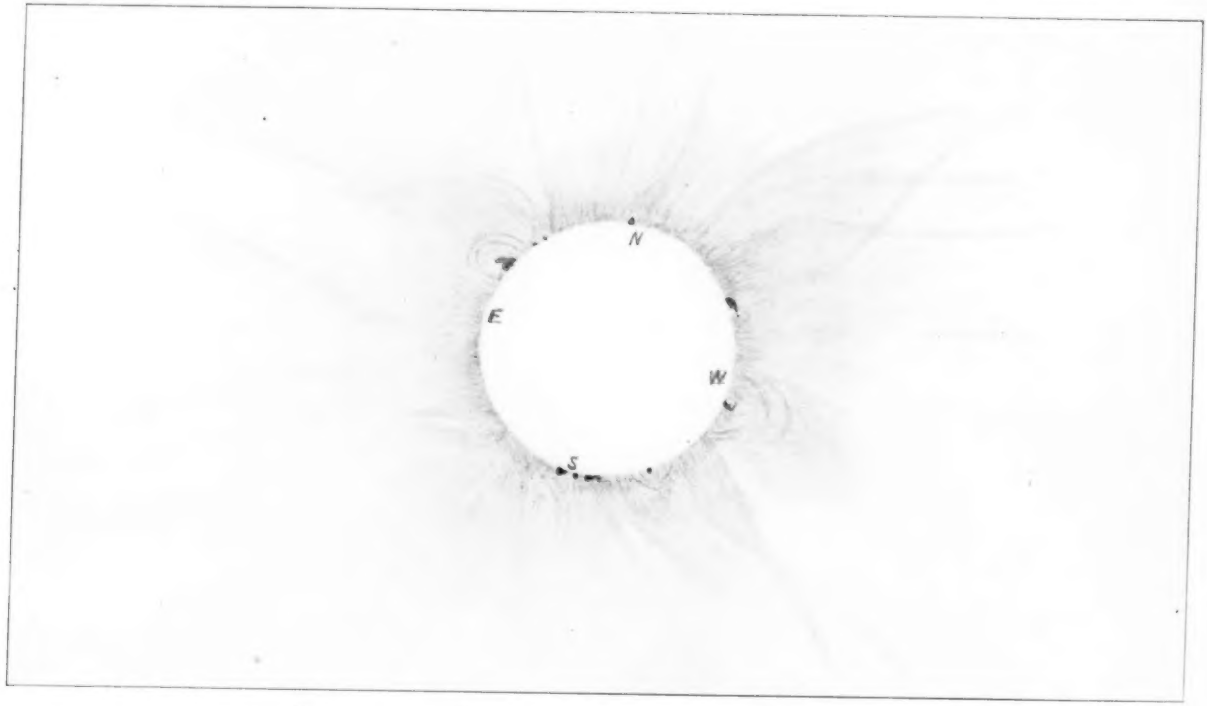
TO NOVA AQUILAE.

Twinkle, twinkle, fickle star!
Fading, fading fast you are.
Yesterday so bright and fair,
Pretty soon you won't be there.

B. L. Taylor.

The Chicago Daily Tribune.
1918 June 18.

PLATE XX



DRAWING OF THE CORONA FROM THE NEGATIVES BY EDISON PETTIT,
AT MATHESON, COLORADO, JUNE 8, 1918.

THE WILLIAM C. SPROUL ECLIPSE EXPEDITION.

JOHN A. MILLER.

The Wiliam C. Sproul Eclipse expedition from Sproul Observatory, Swarthmore College, and Kirkwood Observatory, Indiana University, was located at Brandon, Colo., a station on the Missouri Pacific, approximately 50 miles from the Colorado-Kansas line.

This region is very dry, and the weather conditions are favorable. During the month preceding the eclipse the sun was either clear or only thinly clouded, at 5:26 P. M. on all but six days; and in general the afternoons were better than the forenoons. The wind was usually high, many times very high, and the air many times was full of dust. It was so cloudy on June 5, 6 and 7, and the forenoon of June 8, that at no time could successful observations have been made. This was the longest period of cloudy weather that we had while there. At noon of June 8 however, it cleared, and at the time of totality, only two clouds were visible west of the meridian one about twenty degrees above the sun, and one nearer the horizon. The seeing was fairly steady.

The personnel of the camp included Professor John A. Miller, Swarthmore College, Professor W. A. Cogshall, Indiana University, Lieutenant Lawrence Wheeler, Indiana University, Mrs. John A. Miller, Swarthmore, Pa., Miss Hazel H. Brown, Sproul Observatory, Miss Emma T. R. Williams, Sproul Observatory, and Miss Grace C. Jordan, Springfield, Mass., together with a number of citizens of Brandon, who aided in the observations on the day of the eclipse.

The following instruments were mounted.

I. One lens, 9 inch aperture; focal length 62½ feet. This was mounted, as the Lick observers since 1893 have mounted their long focus lenses. Exposures of 2 seconds, 20 seconds, 45 seconds, and 3 seconds were made with this lens by Professor Cogshall and myself.

II. On a polar axis, two lenses of four inches and three and one-half inches aperture respectively, and of focal length 11 feet, 2 inches, were mounted. The exposure with each of these lenses was for 82 seconds. This instrument on the day of the eclipse was in charge of Miss Grace Jordan.

III. On another polar axis were mounted six lenses varying in focal length from 10½ to 50 inches; also a transmission grating. These instruments were operated by Mrs. Miller and citizens of Brandon.

IV. Another polar axis carried three spectrographs; namely a three-prism slit spectrograph, for the purpose of determining, if possible, the rotation of the corona; a slitless spectroscope, and one of the Littrow type. These were in charge of Miss Emma T. R. Williams and Miss Hazel Brown. A reflector of 15 inch aperture and 12 feet focal length was mounted also—the tube being stationary. The plate at the focus was driven by a device designed by Professor Cogshall. An unfortunate accident to the plateholder during the exposure spoiled the plate, but the mechanism showed that it would be a simple way in which to mount instruments of about this size.

I shall not at present attempt to discuss these plates, but I hope to do so later. They have not yet been intensively examined. The quality of them is very good. They show a wonderful mass of intricate detail. The shorter exposures show the coronal arches that surround the great number of prominences on the rim of the sun, not only the apparently large prominences, but the small ones also. The shape of these arches in general reminds one of Gothic arches, and one cannot resist the temptation to believe the prominences markedly influence the shape of coronal structure. On the longer exposures a very great extension of the corona is shown, and, as one would expect, at some distance away from the sun the structure is very much simpler. The streamers are very much longer than one would expect, since it is so near the sunspot maximum. Some streamers on the plates made with the 11-foot lens are three diameters of the sun in length. The general shape of the corona is triangular, and the longer streamers interlace each other, apparently more than usual. However, on the sun's surface, a very great number of sunspots and great clouds of flocculi could be seen in the focal plane of the 62½ foot telescope, almost any day for two weeks preceding the eclipse. One would naturally guess that the corona would be rather complex.

I was in a dark room and saw the corona only as it was reflected from photographic plate. I saw it the same way with the same lens in 1905. It seemed to me that this corona was not so bright as that one, but photographically it must have been considerably brighter, and it may have been that my memory betrayed me. For those outside of the dark room the spectacle was an extremely beautiful one. There were three huge prominences that were easily visible to the naked eye. I could see the corona in the dark room, reflected from the surface of white paper for four or five seconds after the limb of the sun appeared. The shadow bands were very conspicuous, beginning a little

before totality, lasting a few seconds after totality; beginning again just before totality ended, and lasting a few seconds after totality ended.

Miss Frances Grove, of Brandon, at my request, laid a series of laths down on a sheet spread on the ground, to indicate the width and the direction of the shadow bands. The laths were almost parallel to each other. Later their direction was determined by Mr. Bell, also of Brandon.

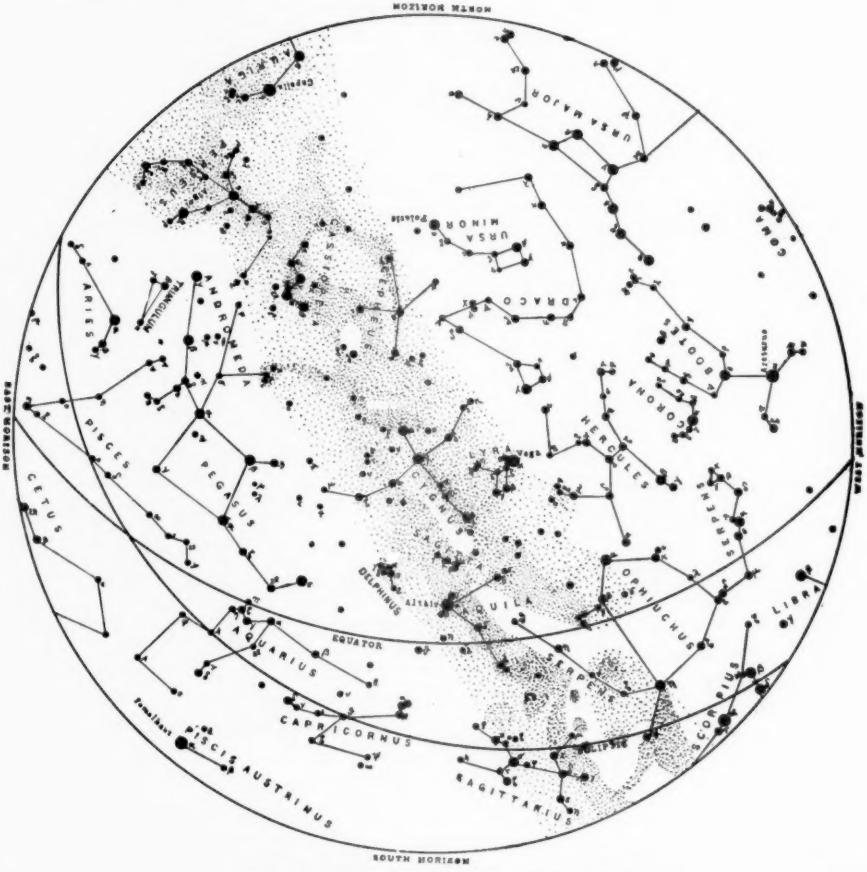
It is difficult and perhaps unnecessary to undertake to assign the responsibility of the work at this camp. The work was initiated at Sproul Observatory. Senator William C. Sproul, to whom we already owe very much here, bore, without solicitation, the entire financial burden of the expedition. Indiana University put at our disposal all of the instruments that Professor Cogshall and I had used in Spain in 1905. The details so far as they applied to direct photography were planned by Professor Cogshall and myself during frequent conferences before going. From the beginning the Lowell Observatory and ourselves planned to coöperate and to duplicate in many respects our observing programs. We interchanged instruments. The Lowell Observatory loaned us two spectrographs, a three prism spectrograph for determining the rotation of the corona and a slitless spectrograph. Director Slipher arranged a Littrow spectrograph from optical parts from the Sproul and Lowell Observatories. The spectroscopic program, at least the details of it, was due largely to him.

Professor Cogshall and myself were at the camp from the beginning and to us fell the greater part of the burden of preparation. Lieutenant Wheeler joined us two weeks before the eclipse occurred, and rendered valuable service every day he was there. Miss Williams, Miss Brown, and Miss Jordan came on Tuesday preceding the eclipse and stayed until it was over. They gave valuable aid in the final adjustment of the instruments. The citizens of Brandon were extremely helpful in every way. The school board not only permitted us to erect our large instruments on the school grounds, but they put at our disposal the school house and two of our polar axes were mounted in the school house, the instruments pointing through doors and windows.

The very high winds usually prevailing had caused us some concern but there was no wind at the time of totality.

PLANET NOTES FOR SEPTEMBER AND OCTOBER, 1918.

The sun will be moving in a southeasterly direction during these two months. At the beginning it will be about 8° north of the equator, on September 23 it will be on the equator, and at the end it will be about 14° south of the equator. September 23 will therefore be the date of the autumnal equinox, the date when the day and night are equal at all latitudes It will pass from Leo through Virgo into Libra. About the middle of October the sun will pass just north of the bright star Spica which will of course not be visible at this time.



THE CONSTELLATIONS AT 9:00 P. M. SEPTEMBER 1.

The phases of the moon for these months are as follows:

New Moon	Sept.	5	at 5 A.M.	C.S.T.
First Quarter		13	" 9 A.M.	"
Full Moon		20	" 7 A.M.	"
Last Quarter		26	" 11 P.M.	"
New Moon	Oct.	4	at 9 P.M.	C.S.T.
First Quarter		12	" 11 P.M.	"
Full Moon		19	" 4 P.M.	"
Last Quarter		26	" 12 P.M.	"

For the summer time of these phases one hour must be added to the times given.

Mercury will be moving westward and emerging from the sun at the beginning of the period. It will therefore swing out rapidly from the sun and reach a point of greatest elongation on September 17. At this time it will be north of the sun and will appear on the horizon as a morning star. It will then move toward the sun and reach conjunction on October 15. It will not be visible again during this period.

Venus will be following the sun eastward during these two months. It will just be visible on the horizon in the morning at the beginning of September but will soon be lost in the rays of the sun. It will, however, not overtake the sun until late in November.

Mars will be sinking lower and lower in the west each evening. It will be to near the horizon for favorable observations during these two months.

Jupiter on the average will come to the meridian at sunrise and will therefore be well situated for early morning observations during these months.

Saturn will rise about two hours after Jupiter. It therefore will also be visible in the morning sky, and well up for observations at least toward the close of October.

Uranus will come to the meridian about nine o'clock in the evening. It will have retrograde motion during this period.

Neptune will be in the same part of the sky as Jupiter. It will be in quadrature, 90° west of the sun, on November 2. It therefore will be visible only before sunrise.

Occultations Visible at Washington.

[*From the American Ephemeris.*]

Date 1918	Star's Name	Magnitude	IMMERSION. Washington M.T. h	m	Angle f'm N. °	EMERSION. Washington M.T. h	m	Angle f'm N. °	Duration h	m
Sept. 16	τ Capricorni	5.2	12	17	70	13	20	238	1	3
19	κ Piscium	4.9	12	14	76	13	23	220	1	9
19	9 Piscium	6.4	12	30	117	13	7	179	0	37
22	27 Arietis	6.4	16	43	78	17	54	254	1	11
24	51 Tauri	5.6	8	58	95	9	47	242	0	49
24	56 Tauri	5.2	9	27	66	10	19	270	0	52
24	67 Tauri	5.4	12	2	34	12	51	300	0	49
25	n Tauri	5.1	9	16	101	10	4	248	0	48
29	209 B Cancri	6.5	16	47	105	18	6	299	1	18
Oct. 20	36 Arietis	6.5	6	22	93	7	9	229	0	48
20	40 Arietis	6.0	8	7	58	9	5	260	0	58
25	2 B Cancri	6.0	12	53	155	13	33	227	0	40
25	5 Cancri	5.9	14	20	130	15	32	260	1	12

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by Julia M. Hawkes and Frank M. Exner at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1918 Sept.-Oct.							
	h m	° ′		d h	d h	d h	d h	d h				
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	8 19				13 17			
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	2 17;	18 1;	3 9;	26 10				
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	11 20;	26 16;	11 13;	26 10				
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	13 11;	28 10;	13 9;	28 8				
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	10 13;	22 18;	11 2;	23 8				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	10 13;	24 19;	9 2;	23 9				
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	10 13;	24 7;	8 0;	21 18				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	10 4;	24 13;	8 21;	23 5				
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	7 14;	25 3;	12 17;	30 6				
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	11 9;	24 7;	13 4;	29 1				
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6	4 9				6 17			
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	8 17;	20 4;	7 9;	24 14				
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	7 15;	28 0;	11 14;	25 4				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	9 19;	25 14;	11 10;	27 5				
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	7 15;	24 6;	10 21;	27 11				
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	5 10;	21 5;	7 0;	22 19				
RW Persei	13.3	+42 04	8.8—11.0	15 04.8	2 13;	28 23;	12 4;	25 8				
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	7 4;	26 2;	5 12;	24 10				
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	10 16;	23 2;	5 12;	30 8				
TT Aurigae	5 2.80	+39 27	7.8— 8.7	0 16.0	7 15;	20 23;	4 7;	24 7				
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	8 14;	24 22;	11 7;	27 16				
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	2 19;	20 20;	2 22;	20 23				
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	10 0;	27 8;	6 0;	23 8				
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	8 2;	28 22;	9 8;	30 3				
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	7 0;	23 1;	9 2;	25 2				
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	4 13;	21 18;	3 5;	20 10				
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	7 15;	24 11;	5 15;	22 11				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	4 16;	21 1;	7 11;	23 21				
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	6 12;	21 18;	7 0;	22 6				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	3 1;	27 11;	9 16;	21 21				
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	8 7;	22 15;	6 23;	21 7				
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	7 8;	20 23;	4 15;	25 1				
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	10 3;	28 18;	8 1;	26 15				
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	2 20;	22 16;	5 22;	25 18				
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	2 5;	27 10;	5 20;	22 15				
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	7 6;	26 13;	9 9;	28 16				
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	5 17;	27 13;	4 19;	19 8				
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	4 17;	20 23;	7 5;	23 11				
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	10 18;	29 17;	9 5;	28 4				
RX Hydrae	9 00.8	− 7 52	9.1—10.5	2 6.8	8 15;	22 8;	12 21;	26 13				
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	7 18;	25 14;	7 10;	25 6				
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	7 18;	28 0;	11 12;	25 0				
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	12 4;	27 0;	4 10;	26 16				
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	7 16;	20 21;	4 2;	23 21				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	8 19;	26 10;	5 5;	22 19				
RW Urs. Maj.	35.4	−52 34	10.3—11.4	7 07.9	8 10;	23 1;	7 17;	22 9				
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	6 6;	26 15;	3 10;	23 18				
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	7 17;	22 17;	7 18;	22 18				
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.2	5 5;	24 9;	3 23;	23 4				
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	6 15;	21 12;	6 9;	21 6				
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	9 22;	30 21;	7 20;	28 19				

Minima of Variable Stars of Short Period—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1918 Sept.-Oct.							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	6 11;	20 6;	10 23;	24 19				
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.3	7 22;	24 19;	3 5;	20 1				
SS Librae	15 43.4	−15 14	9.3—11.5	0 18.4	7 2;	22 9;	7 17;	23 0				
SW Ophiuchi	16 11.1	− 6 44	9.2—10.0	2 10.7	2 21;	24 22;	2 6;	24 6				
SX Ophiuchi	12.6	− 6 25	10.5—11.2	2 01.5	8 1;	24 13;	2 19;	27 14				
R Arae	31.1	−56 48	6.8— 7.9	4 10.2	2 23;	20 16;	8 9;	26 1				
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	10 13;	21 14;	1 7;	22 1				
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	5 4;	25 14;	9 5;	22 19				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	7 8;	24 3;	2 12;	27 16				
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	7 11;	25 22;	8 5;	26 16				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	6 22;	21 8;	5 18;	20 4				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	7 3;	21 20;	6 14;	28 17				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	4 5;	28 18;	6 22;	23 7				
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	4 20;	19 22;	5 0;	27 15				
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	8 0;	23 12;	9 0;	24 12				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	5 11;	21 10;	7 10;	23 9				
WX Sagittae	53.6	−17 24	9.2—10.8	2 03.1	1 16;	27 5;	5 17;	22 18				
WY Sagittae	17 54.9	−23 1	9.5—10.6	4 16.0	5 14;	25 7;	4 15;	23 7				
SX Draconis	18 03.0	+ 58 23	9.3—10.5	5 04.1	9 22;	30 14;	10 23;	31 15				
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 1.00	3 5;	24 23;	2 5;	23 22				
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	4 5;	24 22;	8 18;	22 13				
RZ Scuti	21.1	− 9 15	7.4— 8.3	15 03.2	11 16;	26 19;	11 23;	27 2				
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	7 12;	21 20;	6 4;	20 11				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	3 22;	25 6;	9 11;	23 17				
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	7 17;	24 7;	2 15;	27 13				
RR Draconis	40.8	+62 34	9.3—13	2 19.9	5 8;	22 8;	9 7;	26 7				
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	4 22;	24 21;	8 4;	21 11				
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	13 20;	26 18;	9 16;	22 13				
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	6 16;	21 23;	7 6;	22 13				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	8 9;	23 12;	8 15;	23 19				
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	4 7;	25 22;	3 2;	24 16				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	5 0;	22 22;	10 20;	28 18				
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	5 23;	26 6;	9 19;	23 7				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	8 0;	22 18;	7 11;	22 5				
TT Lyrae	24.3	+41 30	9.3—11.6	5 05.8	4 1;	25 1;	10 18;	21 6				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	2 7;	21 21;	11 11;	24 12				
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	9 10;	21 10;	9 10;	21 11				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	4 18;	18 1;	7 22;	27 20				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	6 2;	24 9;	3 12;	21 19				
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	8 5;	25 1;	3 12;	20 8				
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	4 17;	25 2;	8 15;	22 5				
UW Cygni	19.6	+42 55	10.5—10.8	3 10.8	6 11;	20 6;	10 23;	24 18				
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0		16 14		23 23				
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	4 4;	23 10;	3 0;	22 6				
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	2 20;	21 6;	9 15;	28 1				
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	8 11;	23 11;	8 10;	23 10				
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	2 2;	24 21;	2 11;	25 6				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	5 20;	26 1;	6 3;	26 8				
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	5 1;	27 5;	4 14;	26 18				
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	2 10;	21 19;	1 11;	20 21				
RY Aquarii	14.8	−11 14	8.8—10.4	1 23.2	4 7;	20 0;	5 18;	21 12				
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	2 1;	22 8;	2 11;	22 18				
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	11 1		12 8					
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	3 22;	24 15;	5 0;	25 18				
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.3	7 7;	23 21;	2 4;	27 2				
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	1 20;	24 10;	1 23;	24 13				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	7 10;	23 22;	2 4;	26 21				

Maxima of Variable Stars of Short Period.

[Calculated by Julia M. Hawkes at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5h; Central standard time 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1918. Sept.-Oct.
	h m	° ′		d h	d h d h d h d h d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7	24 10 31 0
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	6 3; 22 9; 8 16; 24 23
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	6 19; 22 6; 7 18; 23 6
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	5 22; 20 17; 5 12; 20 7
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	9 0; 24 21; 10 18; 26 16
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	7 1; 22 16; 8 6; 23 20
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	5 0; 19 14; 4 4; 26 0
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	4 20 6 22
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	6 20; 24 0; 2 14; 19 18
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	11 8; 22 11; 3 14; 25 20
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0	1 7; 24 13; 6 4; 29 10
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	6 7; 21 14; 6 22; 29 21
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3	10 16; 30 22; 11 1; 31 8
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	5 0; 20 11; 5 21; 21 8
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	4 2; 20 16; 7 6; 23 20
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	9 1; 24 4; 9 7; 24 11
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	6 3; 3 4
RT Aurigae	23.0	+30 33	5.1— 6.0	3 17.5	4 0; 26 8; 3 20; 26 4
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	8 15; 23 1; 7 11; 21 20
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	2 9; 26 3; 4 1; 27 19
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	3 6; 23 14; 3 17; 24 1
RU Camelop.	7 10.9	+69 51	8.5— 9.8	12 06.5	14 7; 7 14; 28 20
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	8 0; 23 21; 9 18; 25 16
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	5 9; 25 11; 8 21; 28 23
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	5 10; 23 23; 3 6; 21 19
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	3 6; 20 17; 8 5; 25 17
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 0.00	29
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	4 2; 24 11; 8 0; 21 14
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	6 12; 26 7; 2 22; 22 17
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	10 0; 29 8; 9 0; 28 7
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	5 23; 21 22; 7 20; 23 19
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	4 07; 24 12; 7 23; 28 4
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	5 11; 22 23; 4 14; 22 2
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	9 0; 23 2; 7 4; 21 6
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5	7 16; 24 22; 11 5 29 11
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	2 15; 19 0; 5 10; 21 20
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	5 6; 26 8; 3 8; 24 10
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	9 11; 25 21; 12 7; 28 17
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	1 0; 23 0; 9 11; 25 23
RS Bootis	29.3	+32 11	8.6—10.0	0 09.1	5 13; 20 16; 5 18; 28 9
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	2 5; 17 1; 9 7; 24 3
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	3 23; 17 12; 7 20; 21 9
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	9 1; 21 16; 4 8; 23 7
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1	9 11; 28 23; 8 17; 28 5
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	8 12; 26 6; 5 2; 22 19
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	2 23; 21 3; 3 6; 21 11
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	5 11; 26 11; 3 12; 24 12
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9	5 23; 23 2; 10 5; 27 7
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	6 13; 21 18; 6 22; 22 3
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	6 3; 23 11; 5 0; 22 8
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	4 16; 24 21; 8 9; 28 15
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	5 13; 26 6; 6 14; 27 7
Y Lyrae	18 34 2	+43 52	11.3—12.3	0 12.1	9 20; 21 22; 10 0; 22 2

Maxima of Variable Stars of Short Period—Continued.

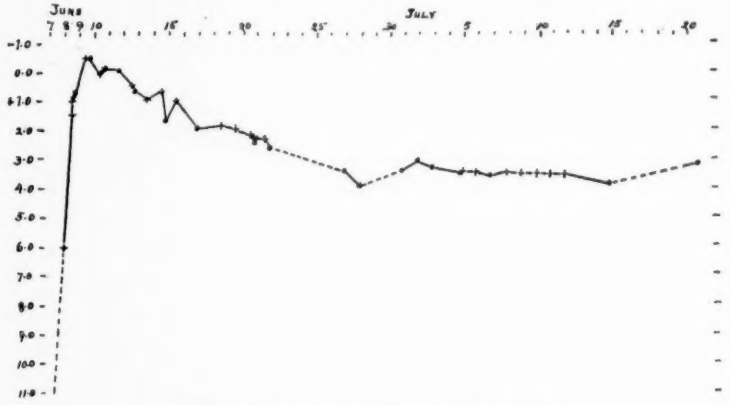
Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1918. Sept.-Oct.							
	h m	° ′		d h	d	h	d	h	d	h	d	h
RZ Lyrae	18 39.9	+32 42	9.9—11.2	0 12.3	12	5;	24	11;	6	18;	25	3
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	7	21;	19	18;	7	15;	25	11
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	11	1;	29	5;	8	8;	26	12
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	7	1;	21	2;	5	3;	19	4
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	4	0;	25	0;	9	0;	23	0
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	8	3;	24	2;	2	2;	26	0
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	3	5;	26	7;	3	23;	27	1
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	8	17;	23	2;	7	10;	21	19
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	3	16;	28	19;	7	4;	23	23
X Vulpec.	19 53.3	+26 17	9.51—0.5	6 07.7	6	3;	25	2;	7	18;	26	17
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	3	17;	20	2;	6	12;	22	21
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	5	17;	23	11;	6	19;	24	12
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	4	16;	18	3;	8	7;	28	12
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	8	18;	22	4;	5	14;	25	17
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	6	14;	21	8;	6	2;	20	19
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	4	0;	19	17;	5	10;	21	3
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	5	20;	26	12;	10	7;	24	2
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	10	14;	20	7;	9	18;	24	8
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	9	0;	26	7;	4	23;	22	6
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	7	8;	23	11;	4	4;	25	15
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	11	6;	22	3;	3	0;	24	18
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	5	12;	24	18;	7	14;	26	20
V Lacertae	22 44.5	+55 48	8.5— 9.5	4 23.6	7	11;	22	10;	7	9;	22	7
X Lacertae	45.0	+55 54	8.2— 8.6	5 10.7	9	16;	20	13;	6	21;	23	5
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	8	16;	25	0;	11	8;	27	15
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	10	10;	23	0;	5	14;	24	12
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	10	12;	22	15;	4	19;	29	2
V Cephei	23 51.7	+82 38	6.0—7.0	0 23.6	7	8;	22	7;	7	6;	22	5

A Brilliant New Star.—On the evening of June 8, following the eclipse of the sun but having no connection with it, a new star of the first magnitude was discovered by many observers independently, including one of the editors of POPULAR ASTRONOMY who was then at Fraser, Colorado. The star is in the constellation Aquila, the Eagle, close to the tail of the Serpent, in R.A. $18^h\ 43^m\ 48''.4$, Dec. $+\ 0°\ 28'\ 21''$.

The first to announce the discovery of the star to Harvard College Observatory was Mr. Warren H. Cudworth, of Norwood, Massachusetts. His prompt notification by telephone enabled the Harvard observers to photograph the star on that night, June 8. Telegraphic announcement came from many persons on the following day, including two European observers, who had the advantage of six to eight hours in time. One of the earliest discoverers was Professor M. Moye, of Montpellier, France, whose communication and estimates of brightness of the star are given below.

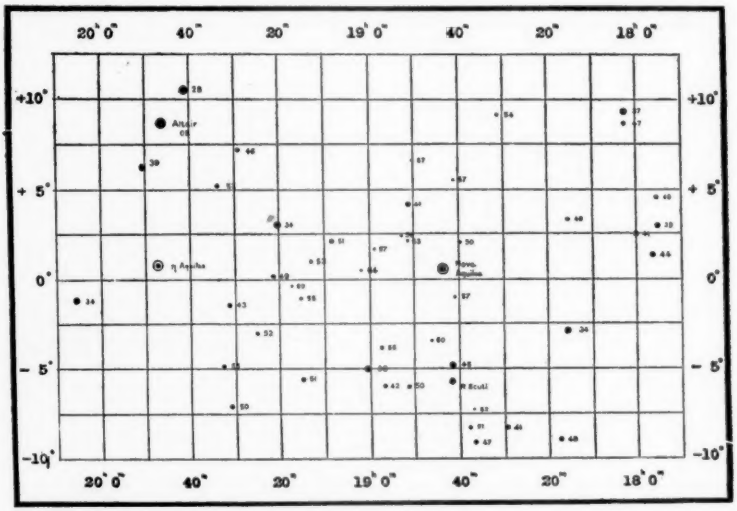
The star is the brightest nova which has appeared since Kepler's star in Ophiuchus which appeared in 1604. It is fortunate that it was caught in its early stages of development and so its changes of brightness and spectrum could be followed, almost from the beginning. Professor Barnard discovered the star at Green River, Wyoming, and Professor Parkhurst photographed its spectrum with the eclipse apparatus, finding the spectrum to be of the first type, with narrow dark lines in a continuous band. This was confirmed by a Harvard plate on June 9. Later, as the star declined in brightness the character of the spectrum changed greatly, assuming the aspect of the spectra of other bright novae, with a few very

broad bright lines accompanied by narrow absorption lines. The broad bright lines appear to correspond to the hydrogen and nebular lines, each having a strong absorption line of perhaps a tenth the width of the bright line on the side toward



PRELIMINARY LIGHT CURVE OF NOVA AQUILAE.

the blue end of the spectrum. On some dates the bright lines (or bands) have an absorption line on both edges; on others weaker absorption lines are superposed on them producing several maxima. On June 26 and 27 a broad absorption



REGION OF NOVA AQUILAE.

band divides each bright band near its middle, producing the effect of the spectra of two masses side by side.

There is no question that much may be learned from the study of these changes of spectrum.

The star rose to magnitude —0.5 or —0.6 on June 9 then began to wane. Professor Barnard estimated it at —1.4 on June 9 but other observers appear to agree that it was not quite so bright as that.

The accompanying cut shows approximately the changes in brightness up to July 20. For this cut we have used only the estimates by H. C. Wilson (represented in the cut by dots) those by Professor Moye of Montpellier, from June 8 to June 21 (represented by crosses) and those of Frank M. Exner of Goodsell Observatory from July 4 to July 11 (represented by crosses). Observations from all possible sources will doubtless be collected at Harvard and an accurate light curve drawn there.

The star is still (July 22) as bright as fourth magnitude and shows no disposition to wane very rapidly, so that observations with the naked eye and with opera glasses may be made for months to come.

The accompanying chart, reduced from one published in the Harvard College Observatory Bulletin 661, will be of value to those of our readers who may wish to practice recording the brightness of the star. The figures printed by the side of each star represent the magnitude of the star, when a decimal point is inserted between the figures.

Following are notes and communications received from various observers concerning the discovery and the subsequent variations of this Nova.

NOVA AQUILAE.—Early yesterday morning I alighted from the train and, as I walked along, I gazed at the sky. The air was beautifully clear—unusually so for this time of the year—and almost at once I saw the new star.

I noted it at 12:43 A. M. Eastern *summer schedule* time. (The *true* time was, of course, 11:43 P. M. June 8.) The color of the star was white with a slight suggestion of blue. When carefully considered, its luster was a trifle superior to that of Altair, but decidedly inferior to that of Vega. Cloudy weather has thus far prevented further observation.

Harvard Observatory, with whom I talked, received many advices about it later in the day, so, as was inevitable, the phenomenon was at once widely observed.

To find, all unheralded, such an object was a most thrilling experience.

WARREN H. CUDWORTH.

Norwood, Massachusetts, June 10, 1918.

NOVA AQUILAE.—I venture to trouble you with my personal impressions when, for the first time of my life, I saw the Nova Aquilæ in early evening of June 8.

At half past eight (Gr. M. T.), it was not dark and Altair was barely visible, when, casually looking in the East, I noticed a faint stellar light where I did not know any noticeable bright star. As we are living under the cloak of the war, I began to think it was an aeroplane with a projector and, afterward, as the mysterious light was immovable, I guessed it would be a comet. An obvious mistake, for the scintillation was intense enough to warn me of the punctiform figure of the new phenomenon, but I was loth to accept it as a new star. Looking through my 4¼ inch refractor and ascertaining I could not see any tail nor any proper motion even with high power, I allowed myself to feel the very agreeable thrill I was either the first or an independent observer of a temporary star. For removing any doubt, I took an atlas and I struck to identify every star on the sky. This done

and the stranger being always shining brighter than ever, I went out to wire news to some astronomical friends of mine.

To return to scientific matters, I append my light estimates of this remarkable star.

LIGHT ESTIMATES OF NOVA AQUILAE.

1918 June	8	9^h	(Gr.	M.	T.) Magn.	= 1.0
	8	1^h	"	"	"	= 0.7
	9	10^h	"	"	"	= −0.5
	10	10^h	"	"	"	= 0.0
	12	10^h	"	"	"	= 0.5
	13	11^h	"	"	"	= 1.0
	14	$10^h\ 30^m$	"	"	"	= 0.7
	15	10^h	"	"	"	= 1.0
	18	11^h	"	"	"	= 1.8
	19	$10^h\ 30^m$	"	"	"	= 2.0
	20	$10^h\ 30^m$	"	"	"	= 2.2
	21	$9^h\ 45^m$	"	"	"	= 2.3

Maximum on the 9th: Nova brighter than Vega. Quick fluctuations on several evenings, 0.2 to 4.4 magnitude in a few minutes. Hue yellowish on the 10th, orange since the 15th.

PROF. M. MOYE,
University of Montpellier, (France).

Montpellier, 1918, June 22.

NOVA AQUILAE No. 3.—This star is shown on my photographs with the Willard lens of the Lick Observatory and the Bruce lenses of the Yerkes Observatory on fifty-four dates—on four dates with the Willard lens and on fifty dates with the Bruce lenses. The first of these was 1892, June 29 with the Willard lens; the last was 1917, March 20. Before the outburst it was of the 10½ or 11 magnitude. These photographs verify the statement made in H. C. O. Bulletin 658 that the star fluctuated in its light previous to its outburst. It seemed to be specially faint in February and March of 1917.

E. E. BARNARD.

Yerkes Observatory,
Williams Bay, Wis.
1918, July 19.

A NOTE ON NOVA AQUILAE No. 3.

[Communicated by Rear Admiral T. B. Howard, U. S. Navy, Superintendent of Naval Observatory.]

The brightness at the time we first saw it at Baker, Oregon, 1918, June 8, $20^h\ 20^m$ G.M.T. was estimated to be midway between that of Altair and Vega, but twenty minutes later it was decided that the Nova was as bright as Vega. During the next hour, sometimes the estimate would be brighter, then again fainter. That these apparent fluctuations were real is doubtful inasmuch as a slight haze would produce the same effect. However, we were at an elevation of over 3600 feet and the sky seemed perfectly clear. The color to the naked eye was more nearly that of Vega than that of Altair. Below are given all the estimates of magnitude that we recorded at the time. They are based upon comparisons with Vega and Altair whose magnitudes we adopted as 0.1 and 0.9 respectively.

G.M.T.	MAG.
$20^h\ 20^m$	0.5
21 35	0.0
22 40	−0.2

As the daylight grew brighter Vega was lost to view several minutes before the Nova.

GEO. H. PETERS.
WM. A. CONRAD.

Nova Aquilae No. 3.—A circular from the Observatory of Marseilles contains the following data of observations of the Nova:

"We have received from Mr. Felix de Roy, London, observations of Nova Aquilæ as follows:

			MAG.	
June	8	$10^h\ 45^m$ G.M.T.	1.09	Pure white
		12 25	1.13	
		14 02	1.02	
June	9	9 35	—0.64	More blue than Vega
		10 20	—0.57	
		11 40	—0.63	
June	10		0.35	Possibly slight suggestion of yellow
	11		0.51	Faintly yellowish
	12		0.60	Faintly but clearly yellowish
	13		0.97	Yellowish

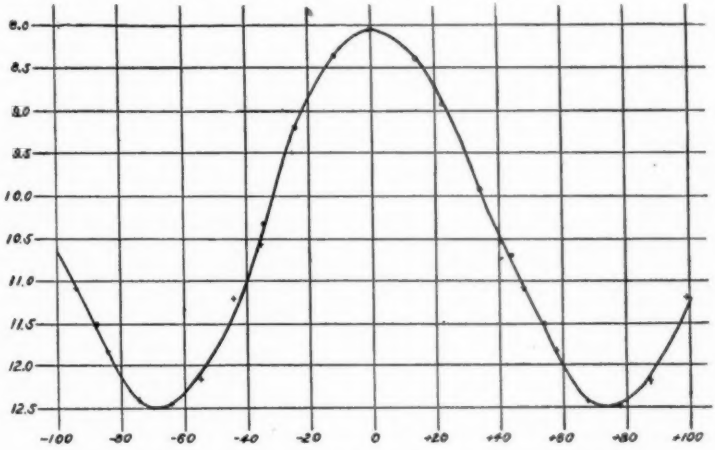
Comparison stars, Vega, Altair, α Cygni. Magnitudes from Harvard Annals Vol. 50. Observations reduced to zenith.

"We have received from Professor Millosevich, Rome, the statement that Captain Piergrossi observed the Nova at Este, in the province of Padua, on June 9, $9^h\ 30^m$ (Etna M. T.). The brightness of the Nova was greater than that of Vega."

Henry Bouget.

June 20, 1918.

Light Curve of X Camelopardalis (043274).—This light curve of X Camelopardalis is based upon observations made by members of the American Association of Variable Star observers from January, 1912 to November, 1917, during which interval the star reached maximum fourteen times.



MEAN LIGHT CURVE X CAMELOPARDALIS
January 1912 - November 1917

The elements resulting from my discussion are:—Max. = 2419668 + 142.57E, with an interval from minimum to maximum of 64.8 days. The average difference between the observed dates of maxima and those computed from these elements

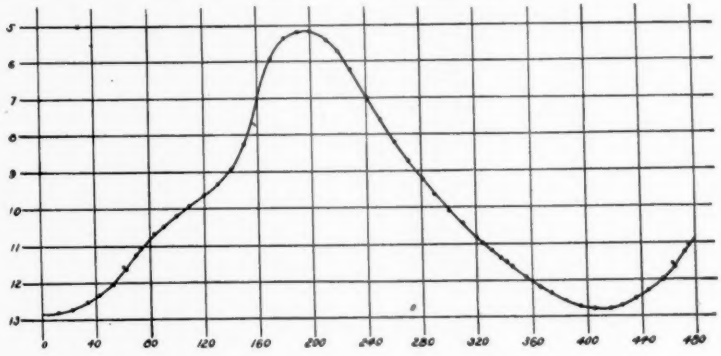
is 3.5 days, with a range from 8.3 to —4.8 days, and we do not consider the fractional part of the day in the period well determined.

Hartwig's elements, given in his 1916 catalogue, are:—Max. = 2416406 + 142.3 E. Combining this epoch with our last observed maximum (J.D. 2421518), we get a period of 142.0 days. MARJORIE THOMPSON.

Mount Holyoke College,
South Hadley, Mass.

Light Curve of χ Cygni (194632).—This light curve is based upon observations made by members of the Association of Variable Star Observers and published in POPULAR ASTRONOMY from January, 1914, to March, 1918.

The single light curves upon which the mean curve is based showed five maxima and four minima, and gave a period of 405.8 days.



MEAN LIGHT CURVE χ CYGNI
January 1912 - March 1918

Hartwig's elements are:—Max. = 237555 + 404.908E + 0.00843E + 25 sin (5E + 300°); according to these elements there should have been an interval of about 407 days between the successive maxima.

The interval of time covered by these observations is not long enough for an accurate determination of elements, but the curve may be of interest to variable star observers. SARA BODDIE DOWNER.

Mount Holyoke College,
South Hadley, Mass.

COMET AND ASTEROID NOTES.

New Comet *a* 1918.—In the *Journal of the British Astronomical Association*, Vol XXVIII No. 7, we find the announcement of the first cometary discovery of the year, made on June 12 by Mr. Reid at Capetown. It appeared as a faint, round nebulosity in R.A. $9^h\ 16^m\ 36^s$ Dec. —8° 10′ Daily motion 48′ due south. It was in such a position as not to be visible in northern latitudes.

Thus far we have seen no verification of this discovery.

Rediscovery of Wolf's Periodic Comet.—By means of an ephemeris calculated by M. Kamensky at the Naval Observatory, at Vladivostok, and published in No. 638 of *The Astronomical Journal*, Professor Barnard was able to find Wolf's periodic comet at its fifth return to perihelion since 1884. The comet is faint, being rated by Barnard at magnitude 14.5. It should be about a magnitude brighter in September and October, but will probably not be conspicuous in small telescopes at its best. It will be very conveniently situated for observation during August and September, describing a short loop in the constellations Vulpecula, Sagitta, and Delphinus.

Kamensky's ephemeris, a portion of which is herewith given, requires very little correction.

EPHEMERIS OF WOLF'S COMET 1884 III FOR BERLIN NOON.

1918		α			δ			log r	log Δ	Aberration Time	
		h	m	s	°	′	″			m	s
Aug.	2	20	19	50.7	+26	48	56	0.3115	0.0804	10	0
	4	20	18	15.3	+26	48	22	0.3091	0.0757	9	54
	6	20	16	40.0	+26	45	40	0.3067	0.0712	9	47
	8	20	15	5.4	+26	40	51	0.3043	0.0668	9	42
	10	20	13	32.3	+26	33	52	0.3018	0.0627	9	36
	12	20	12	1.3	+26	24	39	0.2994	0.0587	9	31
	14	20	10	33.0	+26	13	16	0.2970	0.0549	9	26
	16	20	9	8.2	+25	59	47	0.2946	0.0513	9	22
	18	20	7	47.6	+25	44	10	0.2922	0.0479	9	17
	20	20	6	31.9	+25	26	24	0.2898	0.0447	9	13
	22	20	5	21.6	+25	6	36	0.2874	0.0417	9	9
	24	20	4	17.3	+24	44	50	0.2850	0.0388	9	6
	26	20	3	19.6	+24	21	7	0.2826	0.0362	9	2
	28	20	2	29.0	+23	55	27	0.2802	0.0338	8	59
	30	20	1	45.9	+23	27	58	0.2779	0.0316	8	56
Sept.	1	20	1	10.7	+22	58	46	0.2755	0.0296	8	54
	3	20	0	44.0	+22	27	55	0.2732	0.0278	8	51
	5	20	0	26.3	+21	55	29	0.2708	0.0263	8	50
	7	20	0	18.1	+21	21	36	0.2685	0.0249	8	48
	9	20	0	19.8	+20	46	24	0.2662	0.0237	8	47
	11	20	0	31.5	+20	9	59	0.2639	0.0228	8	45
	13	20	0	53.4	+19	32	26	0.2616	0.0220	8	45
	15	20	1	25.6	+18	53	55	0.2594	0.0215	8	44
	17	20	2	8.1	+18	14	32	0.2571	0.0211	8	44
	19	20	3	1.0	+17	34	23	0.2549	0.0210	8	44
	21	20	4	4.4	+16	53	34	0.2527	0.0210	8	44
	23	20	5	18.3	+16	12	12	0.2505	0.0212	8	44
	25	20	6	42.6	+15	30	23	0.2484	0.0216	8	44
	27	20	8	17.4	+14	48	14	0.2463	0.0222	8	45
	29	20	10	2.7	+14	5	50	0.2442	0.0230	8	46

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, May, June, July, 1918.

The appearance of the Nova Aquilae No. 3 on the night of June 8 is the greatest event of importance directly concerning the interest of the Associotion that has occurred since its inception. This wonderful star, the brightest Nova which has appeared in over three hundred years, was according to the latest information first obseived by M. Luizet of Lyons, France, a few moments prior to its discovery by our

Variable Star Observations May, June, July, 1918.

May 0 = 2421714

001046 X Androm.

J.D. 242	Est.	Obs.
1658.3	9.0	Lt
64.3	9.1	Lt
74.3	9.6	Lt
76.3	9.6	Lt
1719.8	11.0	M
19.8	11.3	Ba
73.8	<11.4	M

001726 T Androm.

1654.3	10.4	Lt
1763.9	<10.7	M

001755 T Cassiop.

1661.3	11.5	Lt
76.7	11.6	Lt
1719.8	10.4	M
19.9	9.0	Ba
35.6	10.1	L
45.4	9.4	L
63.9	8.3	M

001838 R Androm.

1660.3	13.1	Lt
64.3	13.1	Lt
1773.8	<11.0	M

004047 U Cassiop.

1654.5	9.2	Lt
58.4	9.5	Lt
61.3	9.7	Lt
76.6	10.6	Lt
77.4	10.6	Lt
1773.8	<11.1	M

004132 RW Androm.

1773.8	<10.5	M

004435 V Androm.

1664.3	11.0	Lt
76.3	11.3	Lt

004533 RR Androm.

1753.9	9.0	V

004746 RV Cassiop.

1673.8	9.0	M

004958 W Cassiop.

1658.4	11.8	Lt
64.3	11.9	Lt
1757.8	9.8	M

011272 S Cassiop.

J.D. 242	Est.	Obs.
1757.8	9.5	M
73.8	9.0	M

013338 Y Androm.

1654.4	11.1	Lt
64.4	10.6	Lt
76.3	10.6	Lt
79.3	10.5	Lt

014958 X Cassiop.

1658.4	13.1	Lt
64.3	13.1	Lt
1722.6	12.5	Y

015354 U Persei

1658.3	10.7	Lt
76.4	10.7	Lt
84.3	10.7	Lt

021024 R Arietis

1658.3	9.0	Lt
60.3	8.7	Lt
64.3	8.1	Lt
67.3	8.1	Lt
74.3	8.2	Lt
76.3	8.2	Lt
84.3	8.2	Lt

021143a W Androm.

1656.4	12.1	Lt
58.3	11.9	Lt
64.3	11.9	Lt
76.3	11.6	Lt
79.3	11.2	Lt
84.3	11.0	Lt

021281 Z Cephei

1730.6	<13.5	Ba

***021403* o Ceti**

1654.3	7.1	Lt
58.3	7.3	Lt
60.3	7.4	Lt
61.3	7.4	Lt
64.3	7.6	Lt
67.3	7.7	Lt

023080 RR Cephei

1658.4	10.2	Lt
67.6	10.0	Lt
76.5	9.9	Lt
1730.6	11.8	Ba

June 0 = 2421745

023133 R Trianguli

J.D. 242	Est.	Obs.
1654.5	10.0	Lt
58.3	9.7	Lt
64.3	9.6	Lt
75.3	8.9	Lt
76.3	8.9	Lt

024217 T Arietis

1661.3	9.0	Lt
67.3	9.0	Lt

024356 W Persei

1658.4	8.9	Lt
63.4	6.9	Lt
67.5	8.9	Lt
77.4	8.9	Lt

***025751* T Horologii**

1684.5	9.9	δ
87.5	9.6	δ

***031401* X Ceti**

1654.3	9.4	Lt
60.3	9.2	Lt
67.3	9.0	Lt
76.3	9.3	Lt
84.3	9.3	Lt

032335 R Persei

1654.5	9.7	Lt
58.3	9.8	Lt
61.3	9.9	Lt
64.4	10.1	Lt

033362 U Camelop.

1654.5	8.2	Lt
58.4	8.3	Lt
61.3	8.5	Lt
67.5	8.5	Lt
74.3	8.5	Lt
76.5	8.4	Lt

***034124* S Fornacis**

1684.5	8.8	δ
87.5	8.5	δ

***034625* U Eridani**

1684.5	11.0	δ
87.5	10.8	δ

***035124* T Eridani**

1684.5	9.3	δ
87.5	9.0	δ

July 0 = 2421775

042209 R Tauri

J.D. 242	Est.	Obs.
1654.3	10.5	Lt
61.3	9.4	Lt
76.4	9.2	Lt
77.4	9.2	Lt
84.3	9.1	Lt

043065 T Camelop.

1658.4	9.7	Lt
63.5	9.4	Lt
74.3	9.4	Lt
76.5	9.4	Lt
1718.4	8.6	L
30.6	7.7	Ba
35.6	7.7	L

043274 X Camelop.

1654.5	8.2	Lt
58.4	8.2	Lt
63.5	8.1	Lt
74.3	8.4	Lt
76.5	8.4	Lt
1722.6	12.3	Wh
22.6	12.2	Y
30.6	12.5	Ba
48.6	11.5	Y
48.6	11.5	Wh

***043738* R Caeli**

1674.6	12.1	δ
84.5	12.0	δ
87.5	12.3	δ

044617 V Tauri

1684.3	9.7	Lt

***045514* R Leporis**

1660.3	8.2	Lt
67.3	8.5	Lt
76.3	8.5	Lt

***050022* T Leporis**

1674.6	10.1	δ

050849 UX Aurigae

1663.4	8.5	Lt
77.4	8.4	Lt

050953 R Aurigae

1661.3	12.1	Lt
1717.6	<11.5	M
18.6	12.8	B

052034 S Aurigae

J.D. 242	Est.	Obs.
1686.4	9.1	Pe
1718.6	8.8	B

052036 W Aurigae

1718.6	<12.5	B

***052404* S Orionis**

1658.3	8.0	Lt
67.3	8.2	Lt
74.3	9.0	Lt
76.3	9.1	Lt
84.3	9.3	Lt

053068 S Camelop.

1654.5	9.2	Lt
58.4	9.1	Lt
63.5	9.1	Lt
76.5	8.9	Lt

***053005*a T Orionis**

1686.4	9.8	Pe

053920 Y Tauri

1654.4	8.1	Lt
58.5	8.1	Lt
67.5	8.3	Lt
76.4	8.4	Lt

054319 SU Tauri

1715.3	9.6	L
15.5	9.5	B

054974 V Camelop.

1730.6	<13.5	Ba
31.6	<13.0	Ba
32.6	<12.5	Ba
52.6	<12.8	Y

054920 U Orionis

1654.3	11.5	Lt
58.4	11.6	Lt
61.3	11.5	Lt
76.4	10.6	Lt
84.3	10.0	Lt
86.4	10.2	Pe

055353 Z Aurigae

1676.4	11.0	Lt
1717.6	9.3	M

VARIABLE STAR OBSERVATIONS, May, June, July, 1918—Continued.

055686
R Octantis

J.D. 242	Est.	Obs.
1674.6	11.5	δ
86.6	11.1	δ
90.7	10.5	δ
95.6	9.8	δ

060450
X Aurigae

1658.4	9.0	Lt
63.5	8.7	Lt
67.5	8.5	Lt
76.4	8.7	Lt
1716.6	9.3	Hu
29.6	11.5	B
30.6	11.5	Ba

060547
SS Aurigae

1682.5	10.9	Lt
1700.3	<11.6	L
13.3	<11.0	L
14.4	<12.6	L
15.3	<12.6	L
16.4	<12.4	L
16.6	<13.3	B
16.7	<12.4	Wh
18.4	<11.6	L
18.6	<13.8	B
29.6	<12.5	B
31.4	<11.6	L
31.6	<12.4	Y
31.6	<13.0	Ba
32.6	<12.5	Ba
37.3	<10.8	L
37.6	<11.3	B
44.4	<11.0	L
48.6	<12.5	L
48.6	<12.4	Y
52.6	<12.4	Y
53.6	<11.4	Y
57.6	10.8	Y

063159
U Lyncis

1718.7	13.9	B
30.6	13.3	Ba
31.6	<12.0	Y
48.6	14.0	B

063558
S Lyncis

1718.6	12.2	B
30.6	10.7	Ba

064030
X Gemin.

1658.3	11.0	Lt
76.4	12.2	Lt
1731.6	<13.4	Ba

064932
Nova Gem. II

J.D. 242	Est.	Obs.
1714.4	<12.0	L

065111
Y Monoc.

1684.4	10.7	Lt
1732.6	9.3	Y

065208
X Monoc.

1715.3	7.7	L

065355
R Lyncis

1658.5	9.2	Lt
63.5	8.9	Lt
74.3	8.6	Lt
76.4	8.4	Lt
1717.6	8.2	M
18.7	7.5	B
31.6	8.7	Y

070122a
R Gemin.

1654.3	11.3	Lt
58.3	11.3	Lt
60.3	11.4	Lt
86.4	11.9	Pe
1715.6	12.0	Hu
29.6	<12.8	B

070122b
Z Gemin.

1686.4	<12.1	Pe

070122c
TW Gemin.

1686.4	7.8	Pe
1717.6	8.2	M

070310
R Can. Min.

1715.3	8.3	L
15.6	8.0	Hu
16.6	7.8	B
31.3	8.3	L
1731.6	7.9	Ba

071044
L² Puppis

1686.6	4.1	δ
90.6	4.3	δ
92.5	4.5	δ
94.6	4.4	δ
95.6	4.4	δ

071713
V Gemin.

1658.3	12.7	Lt
60.4	12.7	Lt
1716.6	<12.7	B
31.6	<12.3	Ba

072106
Nova Monoc.

J.D. 242	Est.	Obs.
1674.6	9.4	δ
81.5	9.3	δ
84.5	9.3	δ
86.5	9.2	δ
92.5	9.5	δ
95.6	9.6	δ

072708
S Can. Min.

1686.4	<12.3	Pe

072811
T Can. Min.

1716.6	13.2	B

073508
U Can. Min.

1715.6	9.5	Hu
32.6	8.9	Y

073723
S Gemin.

1658.3	11.5	Lt
1716.6	13.6	B

074323
T Gemin.

1654.5	8.5	Lt
58.3	8.2	Lt
63.4	8.5	Lt
74.3	8.9	Lt
76.4	9.0	Lt
1715.6	10.0	Hu
16.6	10.0	Wh
16.6	10.2	V
17.6	9.7	M
29.6	10.9	B
31.6	10.8	Ba

074922
U Gemin.

1644.4	14.0	Lt
76.4	<11.4	Lt
79.4	<12.4	Lt
83.4	<13.0	Lt
1700.3	<11.4	L
13.3	<12.3	L
14.4	<12.3	L
15.3	<11.7	L
15.6	<12.3	Hu
16.4	<11.7	L
16.6	<12.3	Wh
16.6	<11.4	V
16.6	<13.9	B
18.4	<11.7	L
18.6	<13.9	B
19.6	<13.3	Ba
29.6	<13.3	B
30.4	<10.3	L
30.6	<12.5	L
30.6	<12.3	Hu

U Gemin.

J.D. 242	Est.	Obs.
1730.6	<13.3	Ba
31.4	<10.9	L
31.6	<10.9	Y
31.6	<13.3	Ba
32.6	<10.9	Y
32.6	<12.6	B
32.6	<13.0	Ba
37.4	9.2	L
37.6	9.5	B
38.4	9.2	L
39.3	9.3	L
40.4	10.2	L
45.4	<10.9	L

080322
RU Puppis

1674.6	8.4	δ
86.6	8.4	δ
95.6	8.5	δ

081112
R Cancri

1658.3	8.7	Lt
63.4	8.4	Lt
67.5	8.3	Lt
76.4	7.8	Lt
1715.6	6.7	Hu
15.6	7.6	Pt
20.7	7.6	Pt
22.6	6.8	Wh
37.6	7.5	B

081633
T Lyncis

1715.6	8.5	Hu
17.6	8.6	M

081617
V Cancri

1663.4	9.5	Lt
76.4	9.1	Lt
1715.6	7.6	Pt
20.6	7.5	Wh
24.7	7.6	Pt
37.6	8.0	B

082405
RT Hydrae

1695.6	8.0	δ
1715.3	8.4	L
31.3	8.5	L

083019
U Cancri

1716.6	<11.3	V
28.6	<10.7	V
31.6	12.1	Ba

083350
X Urs. Maj.

1731.6	<12.4	Ba
58.7	10.9	B

083409
RV Hydrae

J.D. 242	Est.	Obs.
1695.7	7.3	δ

084803
S Hydrae

1658.4	8.5	Lt
67.5	9.9	Lt
1715.6	11.5	Hu
15.6	11.0	B

085008
T Hydrae

1654.4	9.5	Lt
67.5	9.2	Lt
76.4	9.0	Lt
1731.4	8.5	L

085120
T Cancri

1716.4	9.4	L
22.6	8.6	Wh
31.4	9.3	L
39.3	9.2	L

090151
V Urs. Maj.

1712.3	10.6	Pe
16.6	10.5	Hu
18.4	10.7	L
32.6	10.4	B
37.4	10.8	L
61.6	9.3	Hu

090425
W Cancri

1716.4	<12.0	L
31.6	<12.6	Ba

091868
RW Carinae

1674.6	12.6	δ
86.6	12.1	δ
95.6	12.0	δ

092962
R Carinae

1674.6	6.1	δ
86.6	6.7	δ
90.6	6.9	δ
94.6	7.1	δ
95.6	6.9	δ

093014
X Hydrae

1695.7	12.2	δ

093178
Y Draconis

1722.6	10.8	Y
31.6	11.5	Ba
48.7	12.0	Y

VARIABLE STAR OBSERVATIONS, May, June, July, 1918—Continued.

093934
R Leo. Min.

J.D. 242	Est.	Obs.
1658.3	7.5	Lt
63.3	7.7	Lt
74.3	8.0	Lt
76.6	8.1	Lt
1715.6	8.5	Hu
15.6	9.0	Pt
17.6	8.9	M
18.4	9.3	L
29.6	9.1	B
37.4	10.3	L
46.6	9.5	L
47.4	10.3	L
47.6	10.2	M
59.6	10.0	Hu

094023
RR Hydrae

1695.6	10.9	δ

094211
R Leonis

1658.3	9.5	Lt
63.5	9.2	Lt
67.5	8.9	Lt
74.3	8.5	Lt
76.5	8.5	Lt
79.3	8.5	Lt
1712.3	7.4	Pe
13.3	7.4	L
15.6	7.8	Pt
17.6	6.8	M
20.7	7.2	Pt
30.4	5.9	L
32.7	5.7	B
37.4	5.7	L
45.4	5.5	L
46.6	4.7	Ba
49.6	5.3	Pt
53.6	6.0	M
61.6	5.2	B

094622
Y Hydrae

1674.6	6.6	δ
86.6	7.1	δ
95.6	7.0	δ

095421
V Leonis

1654.4	8.6	Lt
58.3	8.7	Lt
74.3	9.5	Lt
76.5	9.5	Lt
1715.6	10.9	Hu
16.6<11.3		V
18.6	12.1	Me
46.6	13.0	B

100661
S Carinae

J.D. 242	Est.	Obs.
1674.6	7.1	δ
86.6	8.2	δ
90.7	7.9	δ
95.6	8.2	δ

103212
U Hydrae

1654.5	5.1	Lt
58.4	5.2	Lt
60.4	5.2	Lt
61.3	5.2	Lt
63.4	5.2	Lt
65.4	5.2	Lt
67.5	5.2	Lt
74.7	5.0	δ
75.3	5.2	Lt
76.4	5.2	Lt
86.7	5.7	δ
90.6	5.8	δ
95.6	5.7	δ
1714.4	4.6	L
31.4	4.8	L
47.3	4.9	L

103769
R Urs. Maj.

1654.3	12.5	Lt
58.4	12.3	Lt
60.3	12.3	Lt
84.3	11.7	Lt
1717.6	8.7	M
21.8	8.3	M
29.7	7.7	M
30.5	7.9	Ba
32.6	7.5	B
33.7	7.4	M
40.7	7.2	M
45.6	7.2	Ba
47.6	7.0	M
49.7	7.5	Pt
53.6	7.3	M
57.8	7.4	M
71.6	7.5	B
61.6	7.0	Hu
71.7	7.5	B
72.6	7.5	Ba
75.7	7.5	Pt

104620
V Hydrae

1674.6	7.8	δ
86.6	7.6	δ
95.6	8.1	δ
1714.4	8.7	L
31.4	9.0	L
47.3	7.8	L

104814
W Leonis

1746.7<12.7		Y
53.6<13.5		B

110506
S Leonis

J.D. 242	Est.	Obs.
1748.6	11.1	Y

115919
R Comae

1716.6	12.1	Wh
19.6	11.5	M
19.6	11.6	Ba
30.5	10.2	Ba
45.6	8.5	Ba
47.6	8.7	M
48.6	8.7	Wh
48.6	8.5	Y
48.7	8.4	B
59.6	8.6	Hu
70.6	8.3	B
72.6	7.6	Ba

120012
SU Virginis

1730.6<12.8		Ba
52.6<13.5		B
59.6	8.2	Hu
72.6<13.4		Ba

120905
T Virginis

1732.6<12.4		Ba
48.7	13.2	B
70.7<11.8		B

121418
R Corvi

1654.5	9.5	Lt
58.5	9.5	Lt
63.5	10.0	Lt
67.5	10.1	Lt
76.5	10.8	Lt
95.7	10.9	δ
1714.4<11.5		L
29.6	12.6	B
32.6<12.3		Ba
48.7	12.9	B

122001
SS Virginis

1716.6	8.2	Hu
17.6	8.4	M
29.4	9.4	L
30.6	8.0	B
30.6	7.7	Ba
45.4	9.2	L
61.6	8.2	B
70.7	8.0	B
72.6	7.6	Ba

122532
T Can. Ven.

1719.8	12.4	M
19.8	12.5	Ba
60.7	12.2	Wh

122706
S Virginis

J.D. 242	Est.	Obs.
1759.6	11.3	Hu

122803
Y Virginis

1730.4	10.8	L
32.6	10.6	Ba
45.4	9.5	L
48.7	9.4	B
65.7	9.0	B

123160
T Urs. Maj.

1654.4	12.9	Lt
58.4	13.0	Lt
60.3	13.1	Lt
84.3	13.0	Lt
1729.6	9.8	Y
29.7	10.7	M
30.5	10.0	Ba
32.6	10.0	De
40.7	9.2	M
41.7	9.5	Pt
44.7	9.1	M
45.6	8.8	Ba
47.6	8.4	M
48.7	9.0	Wh
52.6	8.6	Y
52.7	8.9	Pt
61.6	8.3	Hu
69.7	8.4	B
71.7	8.7	Pt
72.6	8.1	Ba

123307
R Virginis

1654.5	8.6	Lt
58.4	8.9	Lt
63.5	9.1	Lt
67.5	9.5	Lt
75.3	9.9	Lt
76.5	10.0	Lt
1714.4	8.6	L
21.6	7.1	Hu
30.6	7.4	B
31.4	7.4	L
32.6	7.8	De
32.6	7.5	Ba
41.7	7.7	Pt
47.4	6.7	L
51.6	7.0	Wh
52.7	7.5	Pt
59.6	6.9	Hu
61.6	6.4	B
70.7	7.2	B
75.7	7.9	Pt

123459
RS Urs. Maj.

1732.6<12.2		De
32.6	12.2	M

RS Urs. Maj

J.D. 242	Est.	Obs.
1732.6	13.5	Ba
57.7<11.3		M
69.7<12.8		B
72.6	13.6	Ba

123961
S Urs. Maj.

1654.4	10.9	Lt
58.4	11.0	Lt
77.4	11.5	Lt
84.3	11.4	Lt
1716.7	8.9	Pt
17.6	8.9	L
19.8	8.7	M
20.6	9.2	Wh
20.7	8.5	Pt
28.6	8.7	V
29.6	8.8	Y
29.7	8.5	M
30.5	8.2	Ba
31.6	8.4	L
32.6	8.6	De
40.7	8.3	M
43.6	8.7	V
45.6	8.0	Ba
47.6	8.4	M
48.7	8.3	Wh
49.6	8.4	Pt
52.6	8.6	Y
57.6	8.4	V
61.6	7.9	Hu
69.7	7.8	B
71.7	8.0	Pt
72.6	7.6	Ba

124025
Y Can. Ven.

1654.4	5.2	Lt
58.5	5.2	Lt
64.5	5.3	Lt
67.6	5.3	Lt
75.3	5.3	Lt
76.5	5.2	Lt
79.4	5.3	Lt

124204
RU Virginis

1664.4	11.6	Lt
76.6	11.7	Lt
1727.7	12.1	B
30.6	10.9	Hu
30.6	12.0	Ba
48.7	12.2	B
59.6	12.6	Hu
72.6	13.0	Ba

VARIABLE STAR OBSERVATIONS, May, June, July, 1918—Continued.

124606
U Virginis

J.D. 242	Est.	Obs
1654.4	11.0	Lt
58.4	11.2	Lt
64.4	11.7	Lt
76.6	12.4	Lt
1729.7	11.2	B
30.6	10.6	Ba
48.7	9.8	B
51.6	9.4	Wh
71.6	8.7	B
72.6	8.9	Ba

131546
V Can. Ven.

1654.5	7.0	Lt
58.5	6.8	Lt
65.4	6.7	Lt
67.6	6.7	Lt
75.3	6.8	Lt
76.5	6.8	Lt

132202
V Virginis

1827.6	9.0	B
31.6	8.9	Ba
37.6	9.0	B
61.6	9.7	B
70.7	10.0	B
72.6	9.6	Ba

132422
R Hydrae

1674.7	8.7	δ
95 7	8.4	δ
1714.4	7.8	L
31.4	6.7	L
39.4	6.3	L
58.8	6.7	G

132706
S Virginis

1654.5	8.0	Lt
58.5	8.3	Lt
67.5	8.5	Lt
76.6	8.8	Lt
1714.4	9.7	L
30.6	9.4	Hu
31.4	10.0	L
32.6	11.0	Ba
47.4	10.6	L
51.6	10.5	Wh

133273
T Urs. Min.

1654.3	10.3	Lt
58.4	10.1	Lt
60.3	10.0	Lt
63.5	10.0	Lt
76.4	9.4	Lt
1716.6	9.0	V
28.6	9.1	V
31.6	9.9	Ba
44.6	10.1	V

T Urs. Min.

1457.6	11.0	V
72.	11.6	Ba
73.8	11.6	M

134236
RT Centauri

1674.7	9.8	δ
90.7	9.4	δ
95.7	9.5	δ

134440
R Can. Ven.

1654.3	11.1	Lt
58.4	11.2	Lt
60.4	11.4	Lt
76.5	11.5	Lt
1723.6	12.0	Wh
23.8	11.0	M
27.6	10.6	B
32.6	10.7	Ba
40.8	10.6	M
47.7	10.3	M
57.8	10.1	M
60.7	10.2	Wh

135908
RR Virginis

1732.6	<12.8	Ba
32.6	<11.8	Y
52.6	<12.9	Y

140113
Z Bootis

1676.7	10.0	Lt
1715.8	9.1	M
30.7	9.3	M
31.6	8.7	Y
31.6	8.7	Ba
53.7	10.4	M
57.6	10.1	Y
72.6	9.7	Hu
72.6	12.0	Ba

140512
Z Virginis

1727.6	9.9	B
32.6	10.2	Ba
58.7	10.6	B

140528
RU Hydrae

1674.7	13.3	δ
90.7	13.7	δ
95.7	13.7	δ

140959
R Centauri

1674.7	10.6	δ
86.7	10.8	δ
90.7	10.7	δ
92.5	10.8	δ
95.8	10.7	δ

141567
U Urs. Min.

1654.3	11.9	Lt
1732.6	10.5	Wh

U Urs. Min.

1732.6	10.3	De
32.6	10.0	Ba

141954
S Bootis

1654.5	9.8	Lt
58.5	9.8	Lt
67.6	10.1	Lt
76.5	10.6	Lt
1727.6	13.3	B
29.6	<12.0	L
32.6	<12.0	De
32.6	<13.0	Ba

142205
RS Virginis

1676.7	9.3	Lt
30.6	7.9	B
31.6	7.8	Ba
71.6	8.8	B
72.6	9.0	Ba

142539
V Bootis

1654.5	8.9	Lt
58.5	8.9	Lt
67.6	9.1	Lt
74.3	9.2	Lt
76.5	9.2	Lt
1721.6	10.3	Hu
23.6	9.8	Wh
27.6	9.9	B
29.6	10.3	L
29.7	10.6	M
32.6	10.0	Ba
35.6	10.6	L
47.7	9.7	M
71.7	8.8	B
72.6	9.0	Hu

142584
R Camelop.

1654.3	12.0	Lt
58.4	12.2	Lt
60.3	12.3	Lt
64.3	12.8	Lt
1729.8	<10.8	M
32.6	10.8	Hu
45.6	11.9	Ba
48.6	11.3	Wh
71.7	9.1	B

143227
R Bootis

1658.5	10.0	Lt
60.4	9.9	Lt
63.5	9.8	Lt
67.6	9.3	Lt
76.5	8.7	Lt
1715.6	7.7	Pt
17.6	7.2	M
20.7	7.3	Pt
21.6	7.6	Hu
23.6	8.1	Wh
30.6	7.5	B

R Bootis

J.D. 242	Est.	Obs
1731.6	7.8	Ba
47.7	9.0	M
49.6	9.0	Pt
51.6	9.0	Wh
60.6	9.0	Hu
64.7	9.7	B
72.6	10.2	Ba

144918
U Bootis

1716.6	11.1	V
21.8	10.7	M
27.6	10.9	B
31.6	10.2	Y
31.6	10.7	Ba
47.7	10.5	M
53.6	10.7	B
71.7	11.6	B
72.6	11.4	Ba

150018
RT Librae

1695.7	13.1	δ
1745.6	12.5	Ba

150519
T Librae

1745.6	<12.5	Ba

150605
Y Librae

1745.6	9.0	Ba
53.6	9.8	M

151520
S Librae

1695.7	9.3	δ
1717.6	10.3	L
45.6	11.7	Ba
47.4	<11.2	L

151714
S Serpentis

1715.4	11.2	L
29.7	11.3	M
31.6	11.8	V
45.7	11.2	Ba
49.7	11.0	M

151731
S Cor. Bor.

1654.6	8.1	Lt
58.5	8.1	Lt
65.4	8.3	Lt
67.6	8.3	Lt
74.3	8.7	Lt
76.5	8.7	Lt
1716.7	9.6	V
22.6	9.4	Y
22.6	10.4	Me
23.6	9.6	Wh
27.6	9.7	B
28.6	10.1	V
29.7	9.9	M

S Cor. Bor.

J.D. 242	Est.	Obs
1730.6	9.5	Hu
31.6	9.5	Ba
44.6	10.2	V
46.6	9.0	B
49.8	10.0	M
51.6	10.0	Y
53.6	10.5	Wh
57.6	10.5	V
71.6	11.1	Pi
71.6	10.7	B
72.6	11.0	Ba

151822
RS Librae

1674.7	7.7	δ
90.7	8.7	δ
95.7	9.2	δ
1717.6	9.8	L
45.6	11.4	Ba
47.4	11.7	L
57.6	11.6	B

152714
RU Librae

1695.7	10.7	δ
1745.6	13.0	Ba
57.7	<12.8	B

153378
S Urs. Min.

1654.6	8.6	Lt
58.5	8.7	Lt
67.6	9.0	Lt
76.5	9.3	Lt
1716.7	9.5	V
28.6	10.4	V
32.6	10.0	B
32.6	9.9	Hu
32.6	10.5	Wh
40.7	9.6	M
44.6	10.7	V
45.7	10.4	Ba
55.7	11.1	M
57.6	<11.2	V
71.7	10.5	B

154428
R Cor. Bor.

1654.4	9.6	Lt
58.5	9.3	Lt
60.4	9.3	Lt
63.5	9.3	Lt
64.5	9.2	Lt
65.4	9.2	Lt
67.6	8.9	Lt
76.5	8.6	Lt
79.4	8.9	Lt
84.3	8.3	Lt
86.4	8.1	Pe

VARIABLE STAR OBSERVATIONS, May, June, July, 1918—Continued.

R Cor. Bor.

J.D. 242	Est.	Obs.
1700.3	8.4	L
12.3	8.2	Pe
13.3	8.2	L
15.3	8.2	L
15.6	8.1	Pt
15.7	8.3	M
16.6	8.0	B
16.7	8.0	Pt
16.7	8.3	Wh
16.7	8.1	V
17.6	8.2	M
18.6	8.0	Me
18.7	7.8	B
18.7	8.1	Pt
19.7	7.9	Pt
19.7	8.0	M
19.7	7.9	Ba
20.7	8.0	Pt
21.7	7.9	Pt
21.8	8.0	M
22.6	7.7	Me
23.7	8.0	Pt
23.8	8.0	M
24.6	8.0	Pt
25.3	8.0	L
27.6	7.8	B
28.6	7.7	Pt
28.7	7.4	V
28.8	7.9	M
29.6	7.9	L
29.6	7.9	Pt
29.7	7.5	B
29.8	7.9	M
30.6	7.5	Hu
30.6	8.1	Wh
30.6	7.7	Ba
31.6	7.9	L
31.6	7.7	L
31.6	7.9	Y
31.7	7.8	Pt
32.6	7.6	Ba
32.6	7.5	De
32.6	7.0	B
35.5	7.8	L
35.6	7.7	Pt
35.8	7.9	M
37.4	7.4	L
37.6	9.7	B
39.4	7.6	L
40.6	7.7	Pt
41.6	7.6	Pt
42.7	7.9	M
44.6	7.3	V
44.7	7.6	Pt
45.4	7.5	L
45.6	7.6	Ba
45.6	7.3	B
46.6	7.6	Ba

R Cor. Bor.

J.D. 242	Est.	Obs.
1746.6	7.3	B
47.6	7.6	Wh
47.7	7.4	Pt
47.7	7.8	M
48.6	7.3	B
48.6	7.3	Pt
49.6	7.4	Pt
49.8	7.7	M
51.5	7.4	L
52.6	7.2	B
52.7	7.4	Pt
52.8	7.6	M
53.6	7.9	Y
53.6	7.3	B
53.7	7.4	Pt
54.7	7.5	Pt
54.7	7.4	M
55.7	6.7	G
57.6	7.2	Wh
57.6	7.5	Pi
57.6	7.2	B
57.7	6.9	V
57.7	7.1	Pt
57.8	7.4	M
58.6	7.2	Hu
59.6	7.2	B
59.7	7.1	Pt
59.8	7.3	M
60.7	7.1	Pt
61.6	7.1	B
61.7	7.4	Pt
62.7	7.4	Pt
63.6	7.1	B
64.8	7.3	Pt
65.6	7.2	B
66.7	7.0	Pt
67.7	6.9	Pt
68.7	6.8	Pt
69.7	7.1	B
71.6	7.4	Pi
71.7	7.1	B
71.7	7.4	Pt
72.6	6.9	Ba
74.7	7.1	Pt
75.7	7.2	Pt

154536
X Cor. Bor.

J.D. 242	Est.	Obs.
1716.7	10.4	V
23.8	9.8	M
28.7	9.3	V
29.7	9.7	B
31.6	9.6	Ba
44.7	9.8	V
46.6	9.2	B
49.7	9.4	M
52.6	9.6	Wh
57.6	9.3	V
71.7	9.5	B
72.6	9.6	Ba

154539
V Cor. Bor.

J.D. 242	Est.	Obs.
1658.6	9.3	Lt
67.6	9.3	Lt
76.5	9.4	Lt
1722.6	9.4	Me
31.6	8.2	Ba
49.7	10.2	M
72.6	9.0	Ba

154615
R Serpentis

J.D. 242	Est.	Obs.
1654.5	7.4	Lt
58.5	7.1	Lt
63.5	6.9	Lt
65.4	6.7	Lt
67.3	6.5	Lt
74.3	6.5	Lt
76.5	6.5	Lt
1712.3	8.0	Pe
15.7	8.0	Pt
16.7	7.8	V
21.7	7.9	Pt
28.7	7.8	V
29.7	8.0	M
31.6	7.4	Hu
32.7	7.8	Wh
44.7	8.1	V
45.7	8.1	Ba
49.7	8.3	M
49.7	8.8	Pt
51.6	8.5	Wh
54.7	8.8	B
57.7	8.8	V
71.7	9.3	Pt

154736
R Lupi

J.D. 242	Est.	Obs.
1674.7	12.4	δ
90.7	11.6	δ
95.7	11.3	δ

155018
RR Librae

J.D. 242	Est.	Obs.
1695.7	<14.1	δ

155229
Z Cor. Bor.

J.D. 242	Est.	Obs.
1718.7	11.0	B
29.8	11.3	M
31.6	11.3	Ba
49.7	12.0	M
53.6	12.9	B
72.6	13.5	Ba

155823
RZ Scorpii

J.D. 242	Est.	Obs.
1719.8	8.9	M
19.8	8.8	Ba

155847
X Herculis

J.D. 242	Est.	Obs.
1654.6	7.2	Lt
58.5	6.9	Lt
63.5	7.1	Lt
67.5	7.2	Lt
74.3	7.2	Lt
75.3	7.2	Lt
76.5	7.2	Lt
1715.8	6.9	Mu
16.8	6.8	Mu
20.7	6.8	Mu
21.7	6.7	Mu
27.8	6.8	Mu
28.7	6.7	Mu
31.7	6.7	Mu
45.7	6.9	Mu
55.7	6.8	Mu
58.7	6.9	Mu
59.8	6.8	Mu
61.7	6.9	Mu
63.7	6.9	Mu
65.7	6.8	Mu
71.7	7.0	Mu

160021
Z Scorpii

J.D. 242	Est.	Obs.
1731.5	<11.2	L
51.5	<11.2	L

160118
R Herculis

J.D. 242	Est.	Obs.
1732.7	12.4	De
45.7	<13.8	Ba
49.7	12.2	M
52.6	<13.8	B

160210
U Serpentis

J.D. 242	Est.	Obs.
1654.6	9.1	Lt
58.5	9.2	Lt
63.6	9.3	Lt
67.6	9.7	Lt
76.5	10.3	Lt
1722.6	12.3	Y
29.7	<11.4	M
31.6	<12.7	Ba
57.7	<12.5	B
59.8	12.0	M
72.6	<12.8	Ba

160325
SX Herculis

J.D. 242	Est.	Obs.
1654.6	8.3	Lt
58.5	8.0	Lt
67.6	8.0	Lt
75.3	8.0	Lt
76.5	7.9	Lt

160625
RU Herculis

J.D. 242	Est.	Obs.
1723.8	12.0	M
31.6	13.5	Ba
48.7	13.9	B
49.8	12.4	M
53.6	12.0	Wh
72.6	<13.0	Ba

161122a
R Scorpii

J.D. 242	Est.	Obs.
1695.7	11.6	δ
1719.8	12.6	M
19.8	12.3	Ba

161122b
S Scorpii

J.D. 242	Est.	Obs.
1695.7	12.4	δ
1719.8	11.0	M
19.8	11.0	Ba

161122c
T Scorpii

J.D. 242	Est.	Obs.
1719.8	10.8	M
19.8	10.8	Ba

161138
W Cor. Bor.

J.D. 242	Est.	Obs.
1722.6	12.6	Y
30.6	12.0	Hu
31.7	12.1	Ba
44.8	11.3	M
52.6	11.0	B
52.6	11.0	Y
52.8	11.0	M
53.6	11.1	Wh

161607
W Ophiuchi

J.D. 242	Est.	Obs.
1745.7	<12.0	Ba
53.7	11.4	M

162119
U Herculis

J.D. 242	Est.	Obs.
1716.7	<10.9	V
29.7	11.3	M
30.6	10.4	Hu
45.7	11.3	Ba
48.6	10.8	B
51.6	11.0	Wh
52.8	10.7	M
72.6	10.0	Hu

162112
V Ophiuchi

J.D. 242	Est.	Obs.
1695.7	9.4	δ
1745.7	8.2	Ba
53.7	8.8	M
60.7	7.9	B

162319
Y Scorpii

J.D. 242	Est.	Obs.
1748.6	<13.5	Y

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162542
g Herculis

J.D. 242	Est.	Obs.
1654.4	4.8	Lt
58.5	5.0	Lt
63.5	5.0	Lt
67.5	5.1	Lt
74.3	5.2	Lt
75.3	5.3	Lt
76.5	5.3	Lt
1715.8	5.5	Mu
16.8	5.3	Mu
20.7	5.4	Mu
21.7	5.3	Mu
25.7	5.3	Mu
27.8	5.3	Mu
28.7	5.4	Mu
31.7	5.3	Mu
55.7	5.1	Mu
58.7	5.1	Mu
59.8	5.1	Mu
61.7	4.9	Mu
63.7	5.0	Mu
65.7	5.0	Mu
70.7	4.4	Mu

162815
T Ophiuchi

1753.7	11.7	M

162807
SS Herculis

1676.6	11.3	Lt
1724.7	11.0	Wh
28.8	11.1	M
30.6	11.3	Hu
30.6	11.1	Ba
45.7	12.3	Ba
51.6	12.2	Wh
59.6	11.7	B
72.6	11.1	Ba

162816
S Ophiuchi

1695.7	9.3	δ
1745.6	<12.0	Ba
59.6	12.7	B

163137
W Herculis

1716.7	10.5	V
22.7	10.8	Y
23.8	10.3	M
28.7	9.6	V
31.6	9.5	Hu
31.7	9.9	Ba
44.7	9.2	V
45.7	9.1	Ba
52.6	8.8	B
52.6	9.0	Y
53.7	9.0	M
57.7	8.3	V

163172
R Urs. Min.

J.D. 242	Est.	Obs.
1664.4	9.4	Lt
1723.8	10.2	M
32.6	9.5	Wh
32.6	9.4	B
45.7	9.5	Ba
47.7	10.0	M

163266
R Draconis

1654.3	10.5	Lt
58.4	9.9	Lt
60.3	9.5	Lt
63.5	9.4	Lt
67.6	8.9	Lt
76.4	8.4	Lt
7716.7	8.7	Wh
23.8	8.8	M
29.7	9.0	B
32.6	9.8	Y
44.8	10.4	M
45.7	10.3	Ba
47.7	10.5	M
48.6	10.7	Y
48.6	10.8	Wh
65.6	11.0	B

164055
S Draconis

1658.5	9.2	Lt
76.5	9.1	Lt
1728.7	9.5	M
32.6	9.3	Wh
46.6	8.8	Ba
47.7	9.0	M
57.6	8.8	Wh
58.8	9.2	Pt
75.7	9.1	Pt

164319
RR Ophiuchi

1759.7	10.3	B

164715
S Herculis

1676.6	11.3	Lt
1724.7	11.7	Wh
44.8	11.0	M
46.6	11.0	Ba
51.6	10.5	Wh
52.6	10.5	B
54.7	10.4	M

165030
RR Scorpii

1674.7	6.8	δ
90.6	6.6	δ
94.6	6.4	δ
95 7	6.4	δ

165202
SS Ophiuchi

J.D. 242	Est.	Obs.
1730.6	<12.5	Ba
31.8	<11.5	M
68.7	<12.1	M

165631
RV Herculis

1719.7	11.4	M
19.7	11.3	Ba
28.7	10.8	V
28.7	10.8	M
31.6	10.5	Hu
32.6	10.3	De
44.7	10.7	V
47.7	10.4	M
52.6	11.1	B
52.8	10.7	M
53.6	11.4	Wh
57.7	10.7	V

170215
R Ophiuchi

1695.8	12.2	δ
1753.7	11.4?	M

170627
RT Herculis

1731.7	<12.1	Ba
32.6	<12.2	De
53.6	<13.5	B
59.7	<11.0	M

171401
Z Ophiuchi

1654.6	8.7	Lt
58.6	8.7	Lt
63.6	8.8	Lt
67.6	8.8	Lt
76.6	8.8	Lt
1716.7	8.5	V
28.7	8.4	V
28.7	8.3	M
44.7	9.0	V
46.6	8.0	Ba
53.7	9.3	M
57.7	8.5	V
64.6	8.6	B

171723
RS Herculis

1658.5	8.4	Lt
63.5	8.5	Lt
67.6	8.5	Lt
75.4	8.6	Lt
76.6	8.7	Lt
1721.8	10.3	M
24.7	10.8	Wh
30.6	11.0	Hu
31.7	11.2	Ba
32.6	11.8	De
53.6	12.2	Wh
59.7	12.3	B
60.7	<10.8	M

172809
RU Ophiuchi

J.D. 242	Est.	Obs.
1745.6	13.6	Ba
47.7	12.4	M
57.7	11.7	B

173457
TY Draconis

1712.3	9.4	Pe

175111
RT Ophiuchi

1724.7	10.3	Wh
28.8	9.7	M
45.6	10.1	Ba
51.6	9.4	Wh
59.7	9.3	B
60.8	9.9	M

175458
T Draconis

1664.4	9.4	Lt
76.5	9.8	Lt
1731.6	10.8	Y
46.6	11.0	Ba
57.6	11.2	Y

175458
UY Draconis

1731.6	11.4	Y
46.6	11.2	Ba
57.6	11.2	Y

175519
RY Herculis

1730.7	8.3	M
32.6	9.5	Hu
46.6	8.0	Ba
52.8	8.5	M
59.7	8.9	B
60.7	8.5	M

175654
V Draconis

1746.6	<13.5	Ba

180531
T Herculis

1676.5	9.7	Lt
1715.7	8.0	Pt
16.7	7.5	V
16.7	7.5	Wh
17.6	7.0	L
18.7	7.7	Pt
21.9	7.5	V
28.7	7.9	M
28.7	7.9	V
30.6	8.1	Hu
31.4	8.0	L
32.6	7.9	B
44.7	9.3	V
45.4	9.1	L
46.6	8.9	Ba

T Herculis

J.D. 242	Est.	Obs.
1751.6	9.8	L
51.7	9.5	Wh
53.7	9.4	M
57.7	10.5	V
72.6	11.6	Hu

180565
W Draconis

1732.6	12.5	Ba

180666
X Draconis

1732.6	10.5	Ba

181031
TV Herculis

1731.4	<12.0	L

181103
RY Ophiuchi

1715.7	8.6	M
53.7	9.2	Wh
65.7	10.7	B

181136
W Lyrae

1654.6	8.7	Lt
58.5	8.2	Lt
63.6	7.9	Lt
67.6	7.6	Lt
76.5	7.7	Lt
1715.7	7.8	M
16.7	8.6	Wh
25.8	8.4	M
30.6	8.9	Y
32.6	8.7	B
46.6	10.0	Ba
47.7	10.0	M
51.7	10.2	Wh
52.6	10 2	Y
53.7	10.3	M
65.6	10.8	B

182224
SV Herculis

1730.8	11.8	M
32.6	<12.5	Ba
35.6	11.3	L
48.7	10.4	B
51.6	10.1	L
60.8	9.3	M

182306
T Serpentis

1730.8	8.9	M
59.8	10.2	M

VARIABLE STAR OBSERVATIONS, May, June, July, 1918—Continued.

183149
SV Draconis

J.D. 242	Est.	Obs.
1730.6	10.9	Ba
30.6	10.7	Y
31.8	10.6	M
48.6	11.5	Y

183225
RZ Herculis

J.D. 242	Est.	Obs.
1730.6	12.0	Y
32.6	<12.5	Ba
48.6	12.1	Y
53.7	12.0	Wh

183308
X Ophiuchi

J.D. 242	Est.	Obs.
1640.7	8.7	Lt
54.6	8.5	Lt
58.6	8.5	Lt
63.6	8.3	Lt
76.6	8.3	Lt
1717.6	8.0	L
28.7	7.9	M
35.5	7.8	L
46.6	7.7	Ba
53.7	7.6	Wh
60.8	7.2	M
64.7	7.4	B

184134
RY Lyrae

J.D. 242	Est.	Obs.
1746.6	<15.5	Ba

184243
RW Lyrae

J.D. 242	Est.	Obs.
1732.8	<13.4	M
46.6	<13.4	Ba
46.7	<14.0	B
68.7	<13.4	M

184205
R Scuti

J.D. 242	Est.	Obs.
1654.6	5.9	Lt
58.6	5.9	Lt
63.7	5.9	Lt
76.7	5.9	Lt
90.7	5.2	δ
95.8	5.8	δ
1715.8	4.8	M
17.6	5.2	L
19.7	5.0	Ba
19.7	4.8	M
22.8	5.0	Pt
27.6	5.1	L
29.8	5.2	Pt
29.6	5.2	L
30.8	5.3	Pt
31.6	5.3	L
31.7	5.4	Ba
31.8	5.3	Pt
32.9	5.1	Pt
35.5	5.3	L
36.9	5.4	Pt
37.4	5.4	L
39.8	5.0	Pt
42.7	5.0	M

R Scuti

J.D. 242	Est.	Obs.
1744.7	5.4	Pt
45.4	5.3	L
45.6	5.3	Ba
45.7	5.6	Pt
46.6	5.5	Ba
49.8	5.6	Pt
51.6	5.4	L
52.7	5.8	Pt
54.7	5.7	Pt
55.8	5.7	G
56.7	4.8	M
57.6	5.6	Wh
57.6	5.5	Pi
57.7	5.7	Pt
59.7	5.7	Pr
60.7	6.1	Pt
61.7	5.8	Pt
62.7	5.9	Pt
63.7	5.8	Pt
65.7	6.2	Pt
66.7	6.2	Pt
67.7	6.3	Pt
68.7	6.5	Pt
71.6	6.7	Pi
71.7	6.5	Pt
73.8	6.9	M
74.7	6.5	Pt
75.7	6.1	Pt

184300
Nova Aquilae
No. 3

J.D. 242	Est.	Obs.
1753.4	0.8	Li
53.5	0.9	Fa
53.7	0.5	M
54.6	0.7	Ba
54.6	0.3	Fa
54.8	1.0	M
55.4	0.3	Li
55.8	0.4	M
55.8	0.4	G
56.4	0.5	Li
56.4	0.4	Cr
56.6	0.4	Fa
56.6	0.3	Ba
56.6	0.5	Me
56.7	0.8	J
56.8	0.5	M
57.4	0.9	Li
57.6	0.8	Ba
57.6	0.5	O
57.6	0.4	B
57.6	0.7	Me
57.6	0.4	Wh
57.6	1.0	Y
57.6	1.2	Pi
57.6	0.8	Fa
57.8	0.6	M
58.4	1.1	Li

Nova Aquilae
No. 3

J.D. 242	Est.	Obs.
1758.6	1.1	B
58.6	1.2	Me
58.6	1.0	Fa
58.7	1.0	Ba
59.4	1.1	Cr
59.6	1.2	O
59.6	1.3	B
59.7	1.3	J
59.7	1.6	Pi
59.7	1.1	V
59.8	1.3	Ba
59.8	1.1	M
60.4	1.6	Cr
60.5	1.3	Li
60.7	1.2	V
70.7	1.7	Ba
60.7	1.7	Wh
60.8	1.6	M
61.5	1.5	Li
61.6	2.0	B
61.6	2.0	Wh
61.7	2.0	M
61.8	2.0	Ba
62.7	2.0	V
62.8	2.3	M
63.4	2.7	Cr
63.6	1.7	B
63.6	2.3	Wh
63.7	1.0	Mu
63.7	2.4	M
63.7	2.1	J
64.4	2.9	Cr
64.7	2.1	B
64.6	2.2	J
64.7	2.4	M
64.7	1.1	Mu
64.7	2.1	Ba
64.8	2.1	Pi
65.6	2.3	O
65.6	2.3	B
65.6	2.5	Wh
65.6	2.1	Ba
65.7	1.4	Mu
65.7	2.5	Pi
65.8	2.5	M
66.8	2.6	M
67.7	2.9	V
67.8	2.8	M
68.6	2.5	Ba
68.6	3.0	M
68.8	3.1	M
69.6	2.8	O
69.6	2.5	Wh
69.7	3.0	B
69.8	3.1	Pi
70.6	2.9	B
70.7	2.9	Mu
71.6	3.5	Wh

Nova Aquilae
No. 3

J.D. 242	Est.	Obs.
71.6	3.3	B
71.6	3.5	O
71.7	3.4	Pi
72.6	3.8	Wh
72.6	3.6	Ba
72.6	3.9	Fa
72.7	3.9	Pi
73.8	3.8	M
75.7	3.4	Pi
76.7	3.3	J
77.6	3.2	Fa
77.7	3.2	O
78.6	3.2	O
78.6	3.2	Fa
81.7	3.5	O
82.6	3.6	O
82.6	3.5	Fa

185032
RX Lyrae

J.D. 242	Est.	Obs.
1732.7	12.7	M
46.6	13.0	Ba
68.6	13.6	M

185243
R Lyrae

J.D. 242	Est.	Obs.
1654.6	4.0	Lt
58.5	4.0	Lt
63.5	4.0	Lt
67.5	4.1	Lt
75.4	4.2	Lt
76.6	4.2	Lt

185634
Z Lyrae

J.D. 242	Est.	Obs.
1719.7	<13.3	M
19.7	<13.3	Ba
46.6	<13.3	Ba
68.6	12.8	M

190108
R Aquilae

J.D. 242	Est.	Obs.
1640.7	10.2	Lt
54.6	8.8	Lt
58.6	8.2	Lt
63.7	7.5	Lt
67.6	7.1	Lt
76.7	6.0	Lt
1722.8	6.8	M
52.8	8.4	M
65.7	7.5	B

190529a
V Lyrae

J.D. 242	Est.	Obs.
1717.7	9.4	M
30.6	9.8	Y
46.6	10.5	Ba
48.6	10.9	Y

190925
S Lyrae

J.D. 242	Est.	Obs.
1730.6	<13.5	Ba

190926
X Lyrae

J.D. 242	Est.	Obs.
1728.7	9.1	M
46.6	8.7	Ba
47.7	8.6	M

190967
U Draconis

J.D. 242	Est.	Obs.
1719.7	13.3	M
19.7	13.3	Ba
68.7	11.7	M

191017
T Sagittarii

J.D. 242	Est.	Obs.
1695.8	9.8	δ

191019
R Sagittarii

J.D. 242	Est.	Obs.
1695.8	11.0	δ

191007
W Aquilae

J.D. 242	Est.	Obs.
1762.8	<11.8	M

191033
RY Sagittarii

J.D. 242	Est.	Obs.
1674.7	7.1	δ
90.7	7.4	δ
94.8	7.2	δ
95.8	7.1	δ
1719.8	7.4	M
19.8	7.0	Ba
29.6	7.3	L
35.5	7.0	L
51.5	6.9	L
63.7	7.6	M

191350
TZ Cygni

J.D. 242	Est.	Obs.
1732.6	10.2	Ba
42.7	10.5	M
63.7	11.0	M

191321
Z Sagittarii

J.D. 242	Est.	Obs.
1695.8	10.7	δ
1763.7	11.6	M

191637
U Lyrae

J.D. 242	Est.	Obs.
1746.6	11.5	Ba

192745
AF Cygni

J.D. 242	Est.	Obs.
1654.6	7.1	Lt
58.5	7.1	Lt
63.5	7.2	Lt
67.6	7.3	Lt
74.3	7.4	Lt
75.3	7.4	Lt
76.6	7.4	Lt

VARIABLE STAR OBSERVATIONS, May, June, July, 1918—Continued.

192928
TY Cygni

J.D. 242	Est.	Obs.
1664.5	9.9	Lt
76.6	9.6	Lt
1719.8	11.0	M
19.8	11.1	Ba
52.8	<11.9	M

193311
RT Aquilae

1753.7	12.2	M
63.7	11.4	M

193449
R Cygni

1719.7	<13.1	M
19.7	13.3	Ba
52.7	<13.8	B
68.7	13.7	M

193509
RV Aquilae

1753.7	10.6	M

193732
TT Cygni

1715.8	8.5	M
36.9	7.8	Pt
46.8	8.2	M
58.6	7.5	B
59.7	7.8	Pt
74.7	8.0	Pt

194048
RT Cygni

1654.3	11.8	Lt
76.6	11.5	Lt
1715.8	9.4	M
16.8	9.1	V
19.7	8.7	Ba
28.7	8.9	V
35.8	8.0	M
40.6	7.5	Pt
44.7	7.8	V
45.7	7.8	M
52.7	7.5	B
52.7	7.7	Pt
57.7	7.0	V
60.6	7.6	Wh
62.7	6.8	M
74.7	6.9	Pt

194348
TU Cygni

1676.6	10.5	Lt
1715.8	9.5	M
16.8	9.6	V
19.7	10.0	Ba
28.7	9.6	V
35.8	10.3	M
44.7	10.2	V
45.7	11.0	M
52.7	11.0	B
57.7	11.1	V
62.7	11.8	M

194604
X Aquilae

J.D. 242	Est.	Obs.
1676.7	8.8	Lt
1722.9	9.0	M
53.7	9.8	M
59.7	9.8	B

194632
χ Cygni

1654.6	6.7	Lt
58.6	6.2	Lt
63.6	6.0	Lt
67.6	5.9	Lt
76.6	5.3	Lt
84.5	4.7	Lt
1715.7	5.5	Pt
15.8	5.5	M
21.8	5.6	V
27.8	5.8	M
29.8	5.7	Pt
31.8	5.6	V
35.8	6.0	M
46.8	6.6	M
48.8	6.8	V
49.7	6.6	Pt
57.7	7.1	V
57.7	6.9	B
60.6	7.4	Wh
62.7	7.2	M
74.7	8.9	Pt

195116
S Sagittae

1759.8	6.0	Mu
61.7	6.1	Mu
70.7	6.0	Mu

195849
Z Cygni

1654.3	9.9	Lt
58.7	9.9	Lt
64.3	10.1	Lt
76.6	10.5	Lt
1715.8	11.5	M
21.8	<11.4	V
30.6	12.9	Ba
57.7	12.5	B
60.6	12.3	Wh
62.7	12.0	M

200212
SY Aquilae

1717.6	10.4	L
31.6	10.7	L
35.8	10.8	M
51.6	11.7	L
59.7	11.2	B

200357
S Cygni

1715.8	<11.4	M
53.7	12.8	B

200647
SV Cygni

J.D. 242	Est.	Obs
1715.8	9.1	M
35.8	9.5	M
46.7	9.3	M
58.6	8.5	B

200715a
S Aquilae

1722.8	9.6	M
35.8	10.5	M
52.8	10.7	M

200715b
RW Aquilae

1722.8	9.5	M
35.8	8.5	M
52.8	8.8	M
64.7	9.3	B

200916
R Sagittae

1722.8	8.7	M
35.8	9.1	M
52.8	8.7	M

200938
RS Cygni

1654.6	8.8	Lt
67.6	8.5	Lt
76.6	8.5	Lt
1715.8	7.6	M
17.6	7.5	L
31.6	7.8	L
35.8	8.0	M
45.4	7.6	L
60.6	7.5	Wh

201008
R Delphini

1719.8	<12.8	M
19.8	<13.0	Ba
29.6	12.0	L
31.6	<12.0	L
46.7	8.2	M
58.7	9.4	Pt
59.7	11.7	B
75.7	8.5	Pt

201121
RT Capricorni

1695.8	7.2	δ
1751.6	7.1	L
59.8	7.8	M

201130
SX Cygni

1752.6	<12.9	Y
57.7	13.6	B

201647
U Cygni

J.D. 242	Est.	Obs.
1654.6	8.3	Lt
58.5	8.3	Lt
60.3	8.3	Lt
75.4	8.3	Lt
76.6	8.3	Lt
1715.8	6.7	M
35.8	7.0	M
46.7	7.5	M
58.8	7.7	Pt
60.6	7.2	Wh
75.7	7.4	Pt

202317
W Delphini

1728.8	9.8	M

202539
RW Cygni

1715.8	8.4	M
35.8	9.0	M
46.7	9.0	M
60.6	7.8	Wh

202817
Z Delphini

1728.8	10.6	M
59.8	<11.2	M
65.7	<12.3	B

202946
SZ Cygni

1715.7	9.2	Pt
15.8	9.1	M
19.8	9.0	Ba
29.8	9.4	Pt
30.6	8.9	Ba
35.8	10.0	M
46.7	9.5	M
58.7	8.9	B
58.8	9.4	Pt
60.6	8.9	Wh
60.8	9.2	Pt
64.8	9.5	Pt
72.6	9.0	Ba

202954
ST Cygni

1719.7	12.0	Ba
19.7	12.0	M
48.6	11.2	Y
48.7	11.3	M
52.7	11.0	B
69.7	9.9	B

203226
V Vulpeculae

1722.8	8.9	M
59.8	9.0	M

203611
Y Delphini

J.D. 242	Est.	Obs.
1728.8	10.8	M
59.8	11.7	M

203847
V Cygni

1654.6	8.4	Lt
58.5	8.4	Lt
60.3	8.4	Lt
76.6	8.5	Lt
1715.8	8.6	M
40.7	9.8	M
52.6	9.1	Y
57.7	8.4	B
62.8	9.5	M

203816
S Delphini

1721.8	8.9	V
28.8	9.4	M
31.8	8.9	V
48.8	9.3	V
53.8	9.7	V
54.7	9.8	M

203905
Y Aquarii

1745.8	10.6	M
57.8	11.0	M

204016
T Delphini

1728.8	9.6	M
45.6	<14.0	B
54.7	9.5	M

204104
W Aquarii

1757.8	12.2	M

204405
T Aquarii

1751.8	8.1	M
57.8	7.7	M
60.8	8.5	Pt

204846
RZ Cygni

1719.8	<13.1	Ba
45.8	<11.0	M

205017
X Delphini

1759.7	<13.5	B

205030a
UX Cygni

1745.7	10.8	M
62.8	10.2	M

VARIABLE STAR OBSERVATIONS, May, June, July, 1918—Continued.

205923
R Vulpeculae

J.D. 242	Est.	Obs.
1654.6	8.2	Lt
58.6	8.2	Lt
63.7	8.3	Lt
76.7	8.8	Lt
1740.8	<11.4	M

210129
TW Cygni

1731.8	10.5	M
52.6	10.6	Y
57.7	10.0	B
62.8	10.8	M

210116
RS Capricorni

1762.8	7.4	M

210221
X Capricorni

1762.8	10.1	M

210382
X Cephei

1732.6	<12.5	Ba

210516
Z Capricorni

1763.8	<10.9	M

210504
RS Aquarii

1763.8	11.2	M

210868
T Cephei

1654.6	6.7	Lt
58.5	6.9	Lt
67.6	7.5	Lt
74.3	7.9	Lt
75.3	7.9	Lt
76.6	8.0	Lt
1722.9	8.6	M
29.6	8.5	L
35.5	8.5	L
36.9	8.8	Pt
40.8	8.9	M
55.7	9.2	M

210903
RR Aquarii

1763.8	<11.4	M

211614
X Pegasi

1763.8	10.0	M

211615
T Capricorni

J.D. 242	Est.	Obs.
1763.8	10.5	M

212814
Y Capricorni

1763.8	<11.2	M

213244
W Cygni

1658.6	7.4	Lt
60.3	7.4	Lt
63.6	7.2	Lt
64.3	7.2	Lt
67.6	7.1	Lt
75.3	7.0	Lt
76.7	6.9	Lt
1717.6	5.7	L
29.	5.7	L
31.6	5.7	L
37.4	5.8	L
45.4	5.9	L

213678
S Cephei

1661.3	12.4	Lt
1732.6	12.0	Ba
55.8	<11.6	M

213753
RU Cygni

1722.8	9.0	M
35.8	8.8	M
46.7	9.0	M
52.7	9.0	M
57.6	8.8	Pi

213843
SS Cygni

J.D. 242	Est.	Obs.
1654.3	12.0	Lt
60.3	12.0	Lt
61.3	11.8	Lt
64.3	11.9	Lt
76.6	11.9	Lt
82.5	11.1	Lt
84.5	9.9	Lt
1715.8	11.9	M
17.6	11.6	L
19.7	11.5	M
19.7	11.4	Ba
21.8	11.4	M
21.8	<11.3	V
22.8	11.5	M
23.8	11.5	M
27.6	11.9	L

213843
SS Cygni

J.D. 242	Est.	Obs.
28.8	<11.3	M
29.6	11.6	M
29.8	11.6	L
30.8	11.6	M
31.6	11.6	L
31.6	11.4	Ba
31.8	<11.3	V
31.8	11.6	M
32.6	11.4	Ba
35.5	11.7	L
35.8	<11.3	M
37.4	<10.0	L
39.4	< 9.0	L
40.7	<10.9	M
44.7	10.8	M
45.4	10.0	L
45.6	8.7	Ba
45.7	8.7	M
46.6	8.1	Ba
46.7	8.3	M
47.7	8.3	M
48.6	8.0	Y
48.7	8.3	M
48.7	8.5	B
48.8	8.2	V
49.7	8.3	M
50.8	8.1	M
51.6	8.0	L
51.7	8.2	M
52.6	8.0	Y
52.7	8.6	B
52.8	8.3	M
53.6	8.5	Y
53.7	8.6	B
53.7	8.3	M
53.7	8.6	Wh
53.8	8.3	V
54.7	8.4	M
55.7	8.5	M
56.7	8.7	M
57.6	9.0	Pi
57.6	9.4	V
57.7	9.3	B
57.7	9.3	Pt
57.8	9.0	M
58.7	9.6	B
59.6	9.8	Pi
59.7	9.8	M
59.7	9.8	B
59.7	9.5	Pt
60.6	10.2	Wh

SS Cygni

J.D. 242	Est.	Obs.
60.7	9.5	Pt
60.7	10.2	M
61.7	10.2	B
62.7	11.0	M
63.7	11.5	M
64.6	11.1	B
65.7	11.5	B
69.7	11.5	B
71.6	<11.3	Pi
71.7	11.5	B
72.6	11.6	Ba
73.8	11.9	M

213937
RV Cygni

1728.8	8.0	M
29.8	8.1	Pt
44.7	8.1	Pt
46.8	8.0	M
57.6	8.3	Pi
57.8	7.7	M
59.7	8.0	Pt
74.7	8.3	Pt

214024
RR Pegasi

1763.8	10.4	M

215605
V Pegasi

1721.9	<11.5	V
31.9	<11.5	V
53.8	<11.5	V
63.5	<11.5	M

215717
U Aquarii

1763.8	<10.5	M

221321
X Aquarii

1695.8	12.8	δ

221722
RT Aquarii

1695.8	9.0	δ

222439
S Lacertae

J.D. 242	Est.	Obs.
1654.3	11.8	Lt
64.3	11.1	Lt
76.7	10.7	Lt

225914
RW Pegasi

1721.9	10.1	V
31.9	10.6	V
53.8	<11.2	V

230110
R Pegasi

1719.8	11.2	M
19.9	11.3	Ba
52.8	9.2	M

230759
V Cassiop.

1658.3	10.7	Lt
64.3	10.5	Lt
76.3	9.6	Lt
79.5	9.5	Lt
1721.9	8.0	V
29.8	8.1	Pt
31.9	8.4	V
35.9	8.0	M
44.7	8.8	Pt
45.6	8.8	Ba
52.8	9.6	M
53.8	9.9	V

231425
W Pegasi

1752.8	9.2	M

233335
ST Androm.

1752.8	9.4	M

235053
RR Cassiop.

1752.8	<11.0	M

235350
R Cassiop.

1658.3	6.4	Lt
63.4	6.4	Lt
67.3	6.4	Lt
74.3	6.6	Lt
75.3	6.6	Lt
76.3	6.6	Lt
1752.8	8.4	M
53.9	9.7	V

	May-June	June-July
No. of Observations	1206	709
No. of Stars Observed	238	168
No. of Observers	15	17

member Mr. W. J. Luyten of Deventer, Holland, and our congratulations are extended to Mr. Luyten as an independent discoverer of the Nova and the first of our members to observe this star.

The congratulations of the Association are extended also to the following members of the Association who, in the order named, independently discovered the Nova in this country:—E. L. Gould, Charles Y. McAteer, M. J. Jordan.

By this time the splendid chart of the field of the Nova issued by the Harvard College Observatory is in the hands of all our observers and there is little doubt that the star will be closely observed at every opportunity and that the Association will write a complete and valuable record of the history of this famous variable for posterity to read. This report contains eighty-six observations of the Nova made in twenty-two days, which well attests the value of coöperative observing and the service of the Association is rendering Science.

Two more names of our members are to be added to the Honor Roll of the Association of which we are justly proud. Mr. Nolte has joined the colors, and Miss Vann has been accepted as a volunteer Y. M. C. A. worker abroad.

Mr. M. W. Jacobs of Harrisburg, Pa., one of the group of observers coöperating with the H. C. O. before the Association was formed, contributes observations of the Nova to this report.

Mr. Dawson's list of observations of Southern Variables is of special value. Lists of exceptional merit were received from Messrs. Bancroft, Bouton, and McAteer Mr. Peltier is to be congratulated on the good progress he is making.

Mr. J. G. Lincoln F. R. A. S., a member of the Variable Star Section of the B. A. A., has applied for membership in the Association and contributes under the abbreviation "Li" valuable observations of the Nova to this report.

Mr. Luyten has recently favored us with his published record of observations during the past year, a valuable addition to our records.

Mr. Barns has in hand the publication of a booklet which is to contain reprints of a number of articles on variables that have appeared in POPULAR ASTRONOMY during the past few years. Special articles by several of our members, hints on observing, and other matter of interest and value in the work will also be included in the publication. Thanks to the generosity of Mr. Barns, copies of the booklet will be distributed gratis to our members. The thanks of the Association are due the Editor of POPULAR ASTRONOMY for permission to print the aforesaid material from the pages of this journal.

The following list is cited from Mr. Campbell's list of calculated dates of Maxima and Minima:—

July 2	063558	S Lyncis	Max.	Aug. 1	230110	R Pegasi	Min.
6	021024	R Arietis	Min.	12	163266	R Draconis	Min.
8	195849	Z Cygni	Min.	24	123307	R Virginis	Min.
13	181136	W Lyrae	Min.		162807	SS Herculis	Max.
21	180531	T Herculis	Min.	26	142584	R Camelop.	Max.
23	162807	SS Herculis	Max.				
29	043274	X Camelop	Max.				
31	201008	R Delphini	Max.				

The American Astronomical Society meets at Cambridge, Mass., August 20-23 and our members will be welcome at the meeting. This is a splendid opportunity for our members to meet many astronomers of note and to inspect the historic Harvard College Observatory. It is hoped that many will take advantage of it.

The secretary again requests members to send their lists to him promptly on the *first day* of the month.

The following observers contributed to this report: Messrs. Bancroft, Bouton, Crane, Dawson, Gray, Hunter, Lacchini, McAteer, Mundt, Olcott, Peltier, Pickering, Jacobs, Vrooman, Whitehorn, Miss Young.

WILLIAM TYLER OLCOTT,
Secretary.

Norwich, Conn.
July 10, 1918.

GENERAL NOTES.

Professor Ralph H. Curtiss, of the Detroit Observatory of the University of Michigan, has been detailed through the Navy Department to give instruction in Nautical Astronomy to officers of boats on the Great Lakes. It is expected that this work will continue through the summer. During the coming university year, Professor Curtiss will have charge of the courses in Seamanship and Navigation in the newly established Naval Reserve School of the University of Michigan, at Ann Arbor.

Would not be Eclipsed.—A new record in eclipse observation was perhaps made by an astronomer, Alfred Rordame, of Salt Lake City, in Wyoming, who when he saw that the clouds were not likely to break, jumped into a high powered motorcar and traveled at full speed till he found a bit of clear sky. He was rewarded for his enterprise with some good photographs.—*Springfield Republican.*

A full account of this incident and of the results obtained will appear in the next issue of POPULAR ASTRONOMY.

The Aurora of May 16, 1918.—Another bright aurora was seen here on the evening of Thursday May 16—the third auroral display of more than usual interest that has occurred this spring. It was first noticed a few minutes after nine o'clock (13^h G. M. T.) and developed so rapidly that streamers reached south of the zenith within fifteen minutes. The moon was six days old and so bright as to make it difficult to see the fainter parts of the aurora; but for this, the display must almost have equalled in brilliancy the one of March 7. The color was green, except in a few spots where the light was faintly tinged with red. About 9:30 a very perfect corona was formed in Coma Berenices by the converging streamers and held its shape about three minutes. The same effect appeared, though less perfectly, a little after midnight. During a large part of the display, pulsations of light passed from the horizon toward the zenith at intervals of a few seconds.

JOHN C. DUNCAN.

Whitin Observatory.
Wellesley, Mass.

Brilliant Meteor Observed.—At 9:32 p. m., June 11, from the grounds of Cragg's Hotel, Estes Park, Colorado, a most brilliant and spectacular meteor was observed by a party of astronomers who were visiting the park, having gone to Colorado to observe the solar eclipse.

The meteor burst forth between the stars delta and epsilon Serpentis and traveled in a westerly direction over an arc of 60°. It consisted of a bright nucleus and a tail fully 6° long, and at its widest part was about fifteen minutes across. The head was a bright red while the tail was bluish white bordered with red. The meteor seemed so near that it resembled a terrestrial phenomenon such as a sky-rocket. Its intense brilliance was probably due to the rarity of the atmosphere there, the place of observation being at an altitude of 7700 feet approximately.

Among the party of observers were:—Dean H. A. Howe. Chamberlin Observatory, Denver, Professor P. Biefield, Denison University, Ohio, Professor and Mrs. J. Duncan, Miss H. Livingston and Miss M. Atwood of Wellesley College, Mass., Miss A. J. Cannon, Harvard College Observatory, Professors H. R. Kingston and L. A. H. Warren, University of Manitoba, Winnipeg.

American Astronomical Society.—The twenty-second meeting of the American Astronomical Society will be held at the Harvard College Observatory from August 20 to August 23, 1918. A circular of information has been issued by the Acting Secretary of the Society, Professor Joel Stebbins, and is printed here for those of our readers who may not have received it.

"On the invitation of President Pickering, the Twenty-Second Meeting of the American Astronomical Society will be held at the Harvard College Observatory, Cambridge, Mass., from Tuesday, August 20, to Friday, August 23, 1918. Arrangements have been made for the members and guests, including ladies, to be accommodated in Gore Hall, one of the College dormitories, giving that opportunity for continual personal intercourse which has been so profitable at previous meetings. It is requested that members desiring rooms will notify Professor Pickering promptly, stating names of persons in the party and time of arrival, whether Monday evening or later. The rates will be two dollars daily for meals, and fifty cents for rooms. Rooms may be occupied from Monday night to Thursday night, inclusive, and meals will be furnished from breakfast Tuesday to breakfast Friday, inclusive.

"The Albany and New Haven railways terminate in the South Station, Boston. The entrance to the Cambridge Subway is near the main entrance. The terminus of all Cambride Subway trains is Harvard Square. Members reaching Boston by the North Station should take Cambridge Viaduct cars to Harvard Square. Gore Hall is a quarter of a mile distant on the Charles River Parkway. From Harvard Square, go east two squares to Holyoke Street which leads directly to Gore Hall.

"The distance from Harvard Square to the Observatory is three-quarters of a mile. Take a Huron Avenue car in the Subway to the rear entrance of the Observatory opposite Buckingham Street.

"To avoid carrying baggage, members are advised to send it in advance by parcel post. If they take it by trolly to the Observatory, it will be forwarded to Gore Hall. Evening dress will not be required.

"Titles of papers which are received by the Acting Secretary at Urbana by August 8, will be placed on the printed program, subject to the approval of the Council. It is requested that in as many cases as possible abstracts of each paper be sent in advance."

Fox's Measures of Double Stars.—A review and description of the large volume of double-star measures made by Dr. Philip Fox will be found in POPULAR ASTRONOMY, Vol. XXIV, page 500. Nearly 2,000 pairs are included in this work, and Fox's measures of these have now all been copied into the Extension of Burnham's *General Catalogue*. The detailed examination of the measures thus made necessary has suggested the few following additional notes:

Page 35. Hn 31. It is the *G.C.* position which is given here. The true position is, $14^h\ 31^m\ 37^s$; $-14°\ 59'$

36 Hn 144. Also measured by Pidoux in 1906, but thought to be new by him. (*A.N.* 4138).

Hn 146. The correct position is $18^h\ 37^m\ 17^s$; $-17°\ 40'$.

54. *H* 1009. Measured by Espin in 1907.

57. Hu 907 should be Hu 507.

59. Hd 28, **321.** This is identical with Hd 25, **311.**

72. *H* 3120 should be *H* 2130.

75. Hu 1044 and β 1315. These two pairs are identical.

153. Σ 2078, *AC*. This was measured by Σ, = Σ 30, App. I. Also measured by Doberck, (*A.N.* 4327). The quadrant obtained by Fox differs from that of these two observers.

154. Espin 76, *AC*. This was measured by Espin. (M.N. 71, page 218.)

155. Roe 38. This is not new. Mentioned in *G.C.*, Vol. II, under **7813.**

166. *H* 2266 should be Σ 2266.

171. Espin —, *AC*. Measured by Espin in 1908 and 1910, who obtains a distance about 1″ less. (*M.N.* 69, p. 221 and 71, p. 218).

204. Σ 2873. The mean of the dates should be 1908.523.

205. Espin 146. The pair was wrongly identified by Espin. DM + 52° (3140) is not double. The pair measured by Espin in 1902 is identical with Roe, 93, 22s pr and 1′ s of DM + 52° (3143). Roe mentions eight other companions near. (*A.N.* 4830) . As to the measure of 1903, quoted by Fox, this is accompanied by the note, "Illumination failed." The measure is evidently greatly in error, or some other pair was observed. Espin 146, Roe 93, is fixed.

207 *H* 3109. The position given is far in error. This is the position of β 379, **11668.**

213. Storey — . For 50° 48′ read 50° 58′.

220. *H* 1901. These measures are of *H* 1899, **12503.** Measured also by β and Biesbroeck.

ERIC DOOLITTLE.

University of Pennsylvania,
July 13, 1918.

Corrigenda.—In the article by R. H. Tucker in the June-July number of POPULAR ASTRONOMY the following corrections should be made:

P. 402 in Table B, last "Diff. Long." Jan. 11, 1911, should read 4 25 36.7 instead of 4 25 36.4.

P. 404, line 27, read "And I do not think" etc.

P. 405, line 24, instead of $0^s.4$ read $0^s.04$.; line 37, instead of $+0^s.8$ read $+0^s.28$.